Chapter 2
Theory, Method and Data

2.1 Sustained Yield Industrial Forestry

2.1.1 Introduction

Our aim in Sect. 2.1 is to describe the concepts of preindustrial and industrial forestry with the historically viable concept of sustained yield forestry.

It may surprise some readers to know that, for nearly two centuries, forest economics and forest management as subdisciplines of forest sciences have been dealing with sustainable forestry issues. Forest scientists have been pioneering in issues of sustainable development. Accordingly, we shall next apply some of their theoretical findings.

The word *transition* is defined as passage from one stage to another (Webster 1989). Forest scientists have adopted *transition* as a viable term from demographers (Rudel 1998). Primary forest transition refers here to the process of change, where deforestation is slowing down and turning into increasing forest resources. It is a transition from preindustrial forestry to industrial forestry.

Alexander Mather (2001) introduced the typology of preindustrial, industrial, and postindustrial forestry. In order to understand, explain, and better observe the complex transition processes we link the typology to Kuhn's (1962) revolution of scientific paradigms (Box 2.1) and to Maslow's (1971) theories on the hierarchy of human needs.

In Sect. 2.2 we review the theoretical findings of a number of previous studies on forest transition from preindustrial to sustainable industrial forestry. Then we complement the previous findings by integrating our own theory in Sects. 2.3–2.7.

M. Palo and E. Lehto, *Private or Socialistic Forestry?: Forest Transition in Finland vs. Deforestation in the Tropics*, World Forests 10,
DOI 10.1007/978-90-481-3896-8_2,

Box 2.1 The Science Paradigm and Scientific Revolutions (Kuhn 1962)

A paradigm is described as an "example or pattern" and especially "an outstandingly clear or typical example or archetype" by Webster's ninth new collegiate dictionary. Thomas S. Kuhn (1962) created a theory of science paradigm by studying the evolution of natural sciences, especially physics. We believe that this concept is also a valid instrument to understand the transition from preindustrial forestry to industrial forestry and the ongoing transition from industrial forestry to postindustrial forestry.

The members of a scientific community are the persons uniquely responsible for the pursuit of a set of shared goals, including the training of their successors. Communication is relatively perfect and professional judgments relatively unanimous within such a group of scientists. Scientific communities in this sense exist at numerous disciplines and levels. The global level has become more and more common along with the English becoming the worldwide accepted language of scientific communication.

A membership in a scientific community presupposes that one must have recourse to attendance at specific conferences, seminars, and workshops, to the distribution of draft manuscripts prior to their publishing, and to various other formal and informal communication networks. These scientific communities are the basic modules as the producers and validators of scientific knowledge.

A paradigm, in Kuhn's sense, is a framework of beliefs and standards, which defines the legitimacy of scientific work executed within the applicable discipline. In a pre-paradigm era there may be a number of competing schools (e.g., the Forest Rent School and the Land Rent School in forest economics for a century ago). Afterwards, in the wake of some notable scientific achievement, the number of schools is greatly reduced, often to a single one.

Subsequently, a more efficient mode of scientific practice will begin. Kuhn calls this period "normal science." It is often esoteric and oriented to "puzzle solving" rather than to innovative research. Such a science community can only exist until its members accept the contemporary paradigm as granted. A science paradigm functions as a vehicle for advancing theory and its empirical applications.

Nature and forest ecosystems as a part of it are too complex to be explored at random by a scientist. A paradigm provides him or her a map to guide his/her observations and experiments. A Kuhnian science paradigm comprises more than a set of theories shared by the members of a science community. Kuhn calls "something" more common shared by the members of the same paradigm as a "disciplinary matrix".

(continued)

Box 2.1 (continued)

A disciplinary matrix is assumed to be composed by the elements as follows.

(i) Symbolic generalizations (formal components);
(ii) Metaphysical components (beliefs);
(iii) Values; and
(iv) "Exemplars," which Kuhn considers the most difficult to observe.

The student discovers through exemplars with or without his/her tutor a way to view his/her scientific problem alike he/she already has encountered. He/she can apply analogies between two or more distinct problems by interrelating symbols and attaching them to nature in the ways that have proved productive earlier. In this way the student finally has assimilated "a time-tested and community-licensed way of seeing."

Kuhn concludes that both in ordinary and scientific observations the route from stimulus to sensation is in part conditioned by education. "The members of two groups which have systematically different sensations on receipt by the same stimuli, they do, in some sense, live in different worlds". The members of those groups communicate from "incommensurable viewpoints."

A relevant illustrative case is provided here by the deep cleavage between foresters and conservationists with diverging views of the contents of sustainable forestry in Finland until the 1990s (e.g., Hellström 2001). In scientific observation, interpretation begins where perception ends. "The two processes are not the same, and what perception leaves for interpretation to complete depends drastically on the nature and amount of prior experience and training."

In the evolution of science the superiority of one theory to another cannot be proved through debate. "There is no neutral algorithm for theory choice, no systematic decision procedure which, properly applied, must lead each individual in the group to the same decision. In this sense, it is the community of specialists rather than its individual members that makes the effective decision."

Unexpected novelties through exploration of the unknown do not fit with the development of normal science. They can only occur through a breakdown of an accepted paradigm. Kuhn calls such breakdowns and the consequent transitions to new paradigms as scientific revolutions. They can be large or small but in principle this is the real Kuhnian way of the progress of science rather than a smooth cumulative accumulation of scientific knowledge.

Scientific knowledge similarly with a language is intrinsically the common property of a community or else nothing at all. In order to understand it, we shall need to know the special characteristics of the groups that create and use it. Science is universal by its fundamental nature but it is also historically bound into paradigms.

2.1.2 Concept of Preindustrial Forestry

In preindustrial forestry the objectives of human intervention with forests have varied depending on the mode of action. This period can be divided into the hunting and gathering economy, agricultural conversion of forests, and exploitative logging.

The hunting and gathering economy has been guided by traditional knowledge of hunting, fishing, shifting cultivation and gathering of fruits, medical plants, edible plants, trees and their parts, and other goods and services, e.g., ecological, cultural, and spiritual ones, to satisfy human needs. The objective has been survival or subsistence. In fact, this type of preindustrial forestry is the oldest industry of mankind (cf. Norgaard 1984b). For millions of years the hunting and gathering economy has been practiced in mostly open access forests.

Later, with increasing populations and tribe formation, the hunting and gathering economy was sometimes practiced sustainably under community or private property tenure. Colonization by the European powers disrupted local community ownership in the non-European continents by centralizing forest resources administration. On the other hand, when the population density due to wars, climate change, or other reasons became excessive in comparison with the carrying capacity of the forest ecosystems, the traditional sustainability control of the community property systems often collapsed (Bromley 1991).

In a number of tropical countries a few hundreds of millions of forest people still practice a hunting and gathering economy, mostly shifting cultivation. The hunting and gathering economy without shifting cultivation may, however, soon disappear along with continuous decrease in natural forest cover and globalization and integration of the forest people with the rest of the societies. In the 1990s shifting cultivation was still widely practiced in the Tropics – in about 150 million hectares, mostly in Africa, some in Asia, and a less in Latin America (FAO 2001; Siiriäinen 1987).

Conversion of forests for agriculture and herding has been practiced since the adoption of permanent agriculture 7,000 years ago (Norgaard 1984b). Survival and subsistence were the initial objectives of this activity. Later, poverty alleviation by colonization of forests and profit maximization in export-oriented agriculture appeared as objectives of forest conversion. About 60 million hectares of mostly closed tropical forests were cleared during the 1990s for agriculture and cattle herding, a majority in Latin America, followed by Asia and Africa (FAO 2001).

Cleared forest sites in the tropics may have been used for agriculture-based sustainable development (Wunder 2000) or for a limited period only, after which the sites have been degraded and neglected or to some degree natural reforestation has taken place. Forests in Europe and the United States expanded after the World War II, mostly due to natural reforestation of neglected fields and range lands (Kuusela 1994). However, forest conversion for agriculture has remained the most common pantropical visible local agent for deforestation.

Exploitative logging has been practiced since time immemorial for house and ship construction, fuelwood, and for many industrial purposes. A common objective

in exploitative logging is profit maximization per cubic meter logged (Sundberg and Silversides 1988) and in fuelwood gathering, mostly for survival and subsistence. Industrial logging was about 340 million m^3 and covered about 10 million hectares in the tropical natural forests in 2000 (FAO 2001). However, the total roundwood production was nearly 2 billion m^3 there, and 80% of this amount was composed of fuelwood (FAO 2007).

An empirical illustration of the evolution of preindustrial forestry in Finland will be introduced in Chap. 3.

2.1.3 Concept of Industrial Forestry

In industrial forestry the objective is sustained yield forestry (SYF) (Saari 1949), primarily for industrial purposes. Sundberg and Silversides (1988) defined the objective SYF as maximization of profit per hectare of forest. If this is computed inter-generationally with the Faustmann principle sustainability is included. In this specification benefits and costs of both harvesting and silviculture have to be accounted for, while in the exploitative forestry above only the harvesting phase was considered.

This paradigm was gradually developed along with the expanding international trade by wooden ships, industrialization, and the consequent appearance of scarcity of timber and firewood supplies, especially in Germany and surrounding countries in Europe in the eighteenth and nineteenth centuries.

The stage of industrial forestry is observed by two indicators. The first condition requires that the majority of domestic forests are both *de jure* and *de facto* under SYF. The second condition is that the majority of domestic roundwood production is used for industrial processing in the native country.

The industrial forestry paradigm at its most sophisticated requires privatization of forest property rights as a precondition for its success. Why? Private property rights function closest according to the theoretical ideal (Sect. 2.5) in comparison with the state and community property rights.

German and Austrian pioneering forest scientists developed the idea of sustainable forestry in a formal way during the eighteenth and early nineteenth centuries. Georg Hartig served a long time as a key expert in the Prussian Forest Service. He formulated sustained yield forestry in 1800 as follows: “Every wise Forest Service has to assess its forests without delay, and to try to use them as efficiently as possible under restriction that future generations can use them equally with the present generation” (Vehkamäki 2006, p. 69).

Scientific breakthroughs, such as the model of normal forest (Box 2.2) and forest and land rent theories, were created in support of the paradigm (Box 2.1) of industrial forestry. These new scientific findings were included in the curricula of a growing number of Forestry Colleges (“Forest Academies”) and universities for educating professional foresters during the nineteenth century in Europe, Japan, and India, and later on during the twentieth century in other parts of the world.

Box 2.2 The Model of the Fully Regulated Forest (Normalwald, Normal Forest)

The introduction of the traditional model of the fully regulated forest is helpful in order to understand the different versions under the title of sustained yield forestry (or sustained yield of timber). This model in a way comprises the heart of the sustainability tradition in forestry. Surprisingly, this introduction has often been missing in proceedings dealing with the concept of sustained yield forestry (e.g., Steen 1984). The description provides a case of the paradigm concept as applied in forestry.

Austria, Germany, and Switzerland experienced severe local wood famines since the fourteenth and fifteenth centuries, and especially in the eighteenth and early nineteenth century (Johann 1984; Schuler 1984). Under population and industrial growth as well as under high transportation costs a model of the regulated forest/normal forest was innovated in 1788 by the "Austrian cameral valuation method," and later developed by a number of forest scientists (Judeich 1869). Some primary versions of normal forest appeared even some earlier centuries (Viitala 2003).

In the first application a financial even flow was computed. The financial model was formalized in Austria by C. C. André in 1811 and by his son E. André in 1823. It took 30 years since 1788 until the physical regulation of cut based on similar principles was formulated by a German scientist Karl Heyer. Forestry was supposed to be organized as an ideal machine in order to produce an even flow of wood until perpetuity. If there was a forest holding including evenly different ages of equal-sized stands of total of 100 ha with a rotation of 100 years, then each year one hectare could be cut until perpetuity.

Models are theoretical ideals. With valid argumentation they may reveal findings, which might be impossible to discover by observing the complex real forest ecosystems. The models may never become materialized but they can show relevant direction of practical operations. Still the model of the fully regulated forest has also served both research and practice in many ways. The model of fully regulated forest rests on three basic conditions (König 1854; Judeich 1903; Lihtonen 1959):

- The age structure of the growing stock of trees comprises an equal amount of forest of different vintages under agreed rotation age.
- The growing stock of the whole forest remains constant until perpetuity.
- The annual increment of timber equals continuously the respective annual drain of timber.

In order to facilitate the fully regulated forest with the above conditions the following preconditions must hold. The site productivity must be homogeneous throughout the forest and inter-generationally. One single tree species will be grown with no genetic improvement in the future.

(continued)

Box 2.2 (continued)

No variation in the demand for wood will take place. No climate change will occur. Forest management system must be maintained the same without any risks in its implementation. No pests or natural calamities will occur and the forest will remain healthy. Law, order, and peace must be maintained in the country. If changes will occur in these respects, they should be fully predicted.

This is the physical version of the model of the fully regulated forest with stand-wise management. An illustration has age of the stand on horizontal axis and volume of the growing stock of trees on the vertical axis. The age classes of *n*, 2*n*, 3*n*, and 4*n* are identified on the horizontal axis. The evolution of the volume at each vintage is indicated with a curve. The last vintage of each age class is marked with *a*, *b*, *c*, and *d*.

The Pressler formula (Lihtonen 1959) gives "the normal stock" at the beginning of the growing season as follows:

$$V_{\mathrm{N}} = n \times (a + b + c + d / 2) - d / 2, \tag{2.1}$$

where explanations of symbols above.

Some other simple formulas were applied to regulate practical forestry in the National Forests of the United States during the early twentieth century (Parry et al. 1983). Due to limited available information the von Mantel formula was applied as follows:

$$Y_{\mathrm{a}} = 2G_{\mathrm{a}} / r, \tag{2.2}$$

where Y_{a} = annual yield, G_{a} = growing stock volume, and r = rotation age.

In other words, the allowable annual yield (cut/harvest) was calculated solely from growing stock volume and rotation age. These were at the time the most reliable data in the United States National Forests. When the real forests were mostly old growth and far away from the model of the fully regulated forest the outcome of this calculation raised a lot of criticism.

In 1922 the Hanzlig formula (Parry et al. 1983) was introduced in order to produce more operational outcomes for the western states of the United States:

$$Y = I + V_{\mathrm{m}} / r, \tag{2.3}$$

where Y = annual yield, I = mean annual increment of the immature timber for the rotation, V_{m} = merchantable timber volume above the rotation age.

Often the comparison between annual stem volume increment (growth) and annual timber drain is interpreted as an indicator of sustained yield forestry. By now it is clear that this comparison can be valid only under the distribution of the age classes of forest stands close to the fully regulated forest.

(continued)

Box 2.2 (continued)

In other situations drain has to be compared with the "allowable cut" or "potential cut," which have been computed in order to maintain the cutting options for future generations at least similar what they have been in the past. However, financial sustainability indicators may be most important for forest owners.

The financial aspects of the model of the fully regulated forest requires further assumptions on optimal rotation age and that the chosen profitability indicator (e.g., Weiserprozent) will not decline in each vintage (Judeich 1903). The land rent criterion by Faustmann (1849) in stand-wise management may be more generally accepted.

The model of fully regulated forest and its various indicators were earlier applied in some countries in order to find out how far the real forest was from this ideal model, which as an ideal never could be achieved. The "normal stock" was regarded as the most important indicator. It was needed for computations of "allowable cut" in regulating sustainable yield in forestry. The classical fully regulated forest contains only the remaining growing stock and neglects the role of thinnings, why it is not directly applicable for contemporary Finnish forestry (Lihtonen 1959).

The model of fully regulated forest has generated fruitful ideas for forestry planning in Finland (Lihtonen 1959). For sure, normality and sustained yield forestry are concepts with multiple interpretations. Johnston et al. (1967) never properly defined normality in forestry planning. Still they were highly skeptical of the value of normality in forestry planning.

During the last three decades linear programming has been widely applied in forest management planning, but still the cutting budget calculations have been largely based on the model of the fully regulated forest. The state of the forest in the beginning of the planning period is decisive with regard to how optimal financially the fully regulated forest can appear. It may be an optimal solution in the case, when environmental benefits accrue from the two oldest vintages (Viitala 2003).

So far, we have discussed normality in even age stand forestry. In uneven age forests it is recommended to apply stem frequency series as an indicator of normality. In a fully regulated forest the distribution of stems among different classes of diameters is maintained the same from one period to another. The best-known application in this front is the control method in Switzerland. Another application can be found in Dauerwaldwirtschaft in Germany during the 1920s and 1930s (Lihtonen 1959).

The concepts of the fully regulated forest and sustained yield forestry were familiar in Finland at the wake of the mobilization of the forestry administration and education under rapidly expanding industrial forest exploitation of the second half of the nineteenth century. They never were mentioned in the

(continued)

Box 2.2 (continued)

new forest laws and acts as a mission of a forest policy or as a purpose of a law. Böcker (1829) recommended annual cutting block-wise instead of selection cutting to a minimum diameter.

Later, Gyldén (1853) in Finland described how to plan forestry management in order to approach the state of the fully regulated forest. First, the borders of the forest under planning had to be identified. Then, forests have to be described, surveyed by volume and age classes, classified by sites, rotation ages determined, and the forest divided into operational blocks for annual fellings. As an exemplar of such a plan Gyldén made calculations of sustained timber yield until 2013 (!) for an imagined estate of Halola.

Gyldén's textbook was widely used in the subsequent education of Finnish foresters, in the latter half of the nineteenth century, which may have been one guarantee for the adoption of the concept of sustained yield forestry by the Finnish foresters.

Varying interpretations for observing SYF appeared (Saari 1949). Parallel problems were encountered here as in observing sustainability of national economies (Sect. 2.3). The weakest one was to maintain certain forest area nondeclining (under continuous forest cover/tree growth). A stronger physical interpretation referred to maintaining the growing stock of timber nondeclining over time. The model of "normal forest" (Box 2.2) was created to manage to produce over time a nondeclining roundwood supply.

Equal forestry income over time was one criterion proposed for sustained yield measurement. That naturally varies according to both quantities and qualities of roundwood harvests and prices. A periodically equal income stream covering a full business cycle had been more rational than a strongly variable annual one.

The Faustmann model (König-Faustmann model in German literature) was based on the idea of computing the discounted intergenerational net benefits from afforestation investments and applying the idea of opportunity cost to the capital invested. With this model, land expectation value could be calculated on an even-age monoculture forest in perpetuity. The German forest economist Martin Faustmann (1849) had financial profitability of forestry as a background for developing his famous model.

Some years later Pressler, another German forest economist, developed the soil rent theory for forestry, where the Faustmann model played a key role (Navarro 2003). Soil rent theory has survived until present along with another theory of forest rent as competing cores of the industrial forestry paradigm. The Faustmann model received specific recognition from Paul Samuelson (1976), a Nobel laureate in economics. According to him, the Faustmann model preceded more than half a century the respective findings by Irving Fischer in economics.

The III World Forestry Congress by FAO in Helsinki in 1949 recommended the idea of *progressive forestry*, continuously increasing timber yields, to be followed

by FAO member countries (FAO 1949/1950). This idea coincided with the diffusion of the idea of economic growth as the principal objective of economic policy. The progressive yield idea can be viewed as the strongest physical interpretation of the sustained yield concept in industrial forestry.

2.1.4 Conclusion

Various preindustrial forestry practices have been executing deforestation worldwide and are still in operation in the tropics. Industrial forestry with sustained yield forestry was gradually created about two centuries ago as a strong scientific paradigm shifted to the successive generations of forestry students via educational facilities in different parts of the world. It was often also called "scientific forestry." Foresters and forest scientists can be regarded as pioneers in creating the early versions of the concept of sustainable development. The transition from preindustrial forestry to industrial forestry will be analyzed in a historical perspective in Finland in Chap. 4. It is still under vital research in the tropics (Sect. 2.2) and will be also investigated in Chap. 5 of this book.

Next we shall review the theoretical findings of previous studies on the transition of deforestation/preindustrial forestry to sustainable forestry/industrial forestry.

2.2 Existing Theories of Forest Transition

2.2.1 Introduction

The aim of Sect. 2.2 is to review the existing theories of causes of deforestation and forest transition in order to identify relevant components to our own integrated theory of forest transition in Sect. 2.7.

Beginning in 1962, the forest-based development paradigm (Westoby 1962) dominated development forestry for a couple of decades. FAO and the various international and national development agencies were the principal proponents of this paradigm (Palo 1988; Douglas and Simula 2010). Real forest-based development has, however, been observed only in a few developing countries, e.g., in Chile and Malaysia (Palo and Mery 1996; Douglas 1983).

Boom and bust patterns of log exports and collapses of domestic wood processing have been general in the tropics (Vincent 1992). Instead of forest-based development, serious ecological and social costs of increasing deforestation have mostly occurred in the tropics (Westoby 1978; Douglas and Simula 2010).

A kind of preindustrial forestry is prevailing in most tropical countries. Even if the rhetoric toward sustainable forestry may have arrived in those countries, the *de facto* situation is mostly far away from sustainable forestry practices.

Excess tropical deforestation is creating serious ecological, social, and economic costs for local, national, and global societies (e.g. Palo 1999; Douglas and Simula 2010). Forests, water, health, and food production have many inter-linkages. Tropical deforestation may bring via various linkages lowered health and environment as well as decreases in food production. Decreases in biological diversity and carbon stock have recently received wide global recognition. This is especially true in tropical countries due to their poverty and sensitive ecological conditions.

Hyde and Seve (1991) made an econometric study on expanding afforestation by smallholders in Malawi. Their findings pointed out that increasing fuelwood prices induced the smallholders to increase their investments in fuelwood plantations. The authors generalized their results to all of Africa: the markets will contain deforestation, when scarcity will raise prices enough. They failed to realize that the smallholders operated in special conditions in Malawi, where secure private property rights were prevailing. Elsewhere in Africa the property rights were weak and under unstable political conditions. Both market and government failures were obvious. Higher stumpage prices with higher forest values never materialized. African deforestation has continued since then (Palo 1994).

2.2.2 Role of Agriculture

Concentration of the fertile agricultural land among wealthy landowners has been observed in numerous tropical countries. This has been the origin of great social power for the elite. Accordingly, they have been able to control government, prevent land reforms, and facilitate huge logging concessions to the connected businesses, as has been the case in the Philippines (Saastamoinen 1996).

Development projects have often created roads for clearance of tropical forests for agriculture, mining, and infrastructure. In the most fortunate cases, some agriculture-based sustainable development has taken place on deforested sites (Wunder 2000).

More often the cleared sites have not been fitting for sustained agriculture and they have been left under degradation and erosion as well as to some degree for natural reforestation. On the other hand, prevailing uncontrolled industrial logging has mostly been followed by shifting cultivation, which under population pressure and low human development has led to deforestation.

Mather and Needle (1998) drafted a theory for forest transition based on their empirical studies on the transitions in Europe. It was based on increasing productivity in agriculture under saturated population growth and stable demand for food. Increasing productivity released poorer soils for natural or artificial reforestation.

Rudel (1998) reviewed two hypotheses of forest transition. The first one concerned about how a continued deforestation would induce wood scarcity and increasing wood prices. This again would motivate the forest owners for reforestation or afforestation. The second one dealt with industrialization. Along with this process, migration to cities would decrease labor force in the rural areas. The scarcity

of labor would mean mechanization of agriculture and increasing productivity, while marginal lands would be left over for regeneration of forests.

Rudel (1998) tried to test the hypothesis with empirical data from all countries from 1922 to 1990. In our opinion comparing data from such a long period concerning many different global forest assessments with different scopes and methods is, unfortunately, not viable.

Mather (2004) reviewed first the forest transition theory, which according to him, was still in its infancy. The core idea was that when economic development proceeds, deforestation gives way to reforestation. It is assumed that industrialization and urbanization attract rural migrants, and the subsequent rural exodus leads to retrenchment of agriculture and release of land for reforestation. His findings from an empirical study of forest transition in Scotland, however, did not support these hypotheses. Mather concluded that his findings would not negate the role of development in forest transition but there must exist some other causal factors not revealed by his study.

Later on, Rudel et al. (2005) reviewed the causes for forest transitions to stem in the first instance from urbanization and economic development. They facilitate farm workers to migrate from the countryside, which in turn will increase labor shortages and result in higher wages and make agriculture on poorer and more remote sites unprofitable. These idle sites then revert to forest by natural or artificial regeneration. This transition is reminiscent of the Kuznets curve. In the second instance, with little ability to import forest products the scarcity due to deforestation spurs increases in the prices of forest products, which motivates the forest owners to plant trees.

2.2.3 Other Explanations of Forest Transition

Wunder (2000) introduced three theoretical frames for deforestation studies: "impoverishment," "neo-classical," and "political ecology." Wunder's 'impoverishment' and 'political ecology' as such appear too narrow to be used as an integrated theory. The neo-classical theory is invalid in mostly non-market contexts in the tropics.

Perz and Skole (2003) reviewed the existing forest transition theory, especially the Kuznets hypothesis of forest cover first declining and then the rise of income per capita turning into expansion. Forest cover was expected to follow a U-shape pattern. They observed in Brazilian Amazonia after logging of a primary forest a vigorous re-growth of secondary forest. They suggested some differentiation of the two processes.

Xu et al. (2007) studied forest transition in five case districts in China. They found that this transition was facilitated by scarcity of timber, secured local property rights, and economic development. They concluded that a land use decision is often also a water use decision. The authors stressed the need for further studies on the

impacts of tree plantations on watercourses and biodiversity. They discovered also some geopolitical consequences of the expansion of plantation forests.

Mather (2007) returned to the issue of forest transition with empirical data from China, India, and Vietnam. Forest transitions in these countries took place under relatively low national income per capita levels. The findings suggest firstly that more than the two pathways of transition reported above by Rudel et al. (2005) may exist. Secondly, the results showed that relationships with indicators of modernization and economic development are complex. Forest transitions cannot only be outcomes of a rural exodus or rising agricultural productivity. In each of the three countries radical changes in government policies had taken place during the times of transition.

Perz (2007) reviewed widely the research done in the field of forest transition. He was quite critical on the 'leading' theories of modernization (urbanization) and economic development with Kuznets curve and doubted, if they were supported strongly enough with empirical evidence. He pointed out that more care should be devoted to the concept of forest. He recommended historical-comparative analyses and interdisciplinary theoretical frameworks with general systems theory applications.

Geist and Lambin (2002) reviewed a number of micro studies on tropical deforestation. They developed an integrated framework for understanding deforestation. It consisted of five broad clusters of driving forces (underlying causes), which were composed of demographic, economic, technological, policy, and cultural factors. They lie behind the multiple proximate causes. The proximate causes included infrastructure extension, agricultural expansion, wood extraction, and other factors with environmental, biophysical, and social trigger events (e.g., wars, economic shocks, etc.).

Geist and Lambin (2002) based their framework on studying 152 local case studies of deforestation. The identification of proximate and underlying causes was based on the frequency of these causes in the case studies. "Causal factors were quantified by determining the most frequent proximate and underlying factors in each case. The major interactions and feedback processes were also identified between these factors to reveal the systems dynamics that commonly lead to deforestation" (p. 144). The authors followed a kind of bottom-up procedure in their theory formation.

Lambin and Meyfroidt (2010) found three paths based on recent case studies of different countries. They were composed of a globalization path, a state forest policy or government-led path, and a smallholder/tree-based land use intensification path. The globalization path was determined as an extension of the previous economic development path driven by global demands for tourism and conservation.

Deforestation can be regarded as a socio-economic-ecological process, which mostly lies external to the traditional controls of markets and governments. Therefore, the theories of neo-classical economics as such cannot provide sufficient theoretical basis. According to Douglass C. North (2005), a Nobel laureate in economics, we cannot understand economic change alone without grasping also political and social change.

2.2.4 Conclusion

The above review of the forest transition studies revealed the missing consensus of forest transition theories. Therefore, the theory is revisited here toward the direction given by Perz (2007) above. We will apply the above findings on causes of forest transition by identifying of the inter-sector and international factors in the model of Fig. 2.4 below.

We will base our framework partly on the findings of this review and partly complement it by the theories below. We will finalize a somewhat similar framework as above by Geist and Lambin (2002). We have developed our own framework since the 1980s (Palo 1987, 1990). We will concentrate below on ecological and institutional factors of the underlying causes of deforestation (Fig. 2.4).

In the following section the theory of ecological economics is introduced to complement the findings of this section.

2.3 Theory of Ecological Economics

2.3.1 Introduction

We aim in this section to review ecological economics in order to find ways how to integrate ecological conditions into our analyses of forest transition and into the interaction of forestry and society.

It has been also argued that due to many ecological constraints, such as harsh climate, poor and erosion-sensitive soils, and animal (e.g., tsetse fly) and human health (e.g., malaria) hazards, the development threshold has been higher in the tropics than in the temperate and boreal ecological zones (e.g., Kamarck 1976; Sachs 2005).

Nicholas Georgescu-Roegen was one of the first economists to investigate the interplay between economic activity and natural environment in the light of thermodynamics. He developed a comprehensive theory on sustainability based on economy, society, and environment after 1960, during the latter part of his career (Mayumi 2001).

Ecological economics has been developed with this specific name since the 1970s, when scientists from economic, social, and natural science disciplines have been engaged in discovering new approaches to economic development and its environmental challenges. Its central focus is sustainable development. Ecological economics does not constitute a unified theory of sustainable development but it signals rather the need for economic, social, and natural science analyses to be brought together in new perspectives.

2.3.2 Concept of Sustainability

Ecological economics is responding to the global concerns for ecological, social, economic, and political dimensions of sustainability. According to one brief definition,

"ecological economics studies how ecosystems and economic activity interrelate." In ecological economics analytical tools and concepts coming from economics and some other disciplines are commonly applied (e.g., Faber et al. 1996).

The concept of sustainability appeared perhaps first in the "World Conservation Strategy" (IUCN 1980) in the context of development. The most influential report in this respect was "Our Common Future" (WCED 1987) by the United Nations Committee chaired by the previous Norwegian Prime Minister Gro Harlem Brundtland. Its definition, "Sustainable development is development that meets the needs of the present without compromising the ability of the future generations to meet their own needs," has become a worldwide standard.

Pearce and Turner (1990, p. 24) were among the early environmental economists to define sustainable development: "It involves maximizing the net benefits of economic development, subject to maintaining the services and quality of natural resources over time." The sustainability restriction for renewable resources was aimed to utilize them at rates less than or equal to the natural rate at which they can regenerate. This idea is parallel to the comparison of annual drain and increment in sustainable forestry, as we shall discuss later (Box 4.1).

According to another interpretation of sustainability the natural capital stock should remain constant. How should this be followed up? Alternative solutions were given. The capital stock is constant if its physical quantity does not change. This may imply commensurability problems. Another way would be to assess monetary values to each type of resource and count the overall aggregate value. It implies valuation problems. One alternative could be to balance constant value of resource flows, where the value may be changed either by a change in price or quantity or both (Pearce and Turner 1990).

Adamowicz (2003) reviewed economic and forestry sustainability indicators. Among a few alternatives he defines first a Green Net National Product as consumption plus change of capital times the price of capital. Then he turns to the case of forestry, where the change in value of forest resources equals with (price minus marginal cost) times (net growth minus harvest). This expression has some strong assumptions behind it. First, he assumes prices as "correct" for the sustainable path. Second, an even age class distribution is assumed as in the normal forest model.

Adamowicz (2003) also doubts the idea of accounting sustainability for a single sector of society, such as forestry. He wonders too about the correct spatial scale for assessing sustainability. Assessment of non-market goods and services is essential for sustainability but liable for biased valuation. He also doubts the rationality of separate ecological, social, and economic accounts; economic analysis should rather integrate these elements.

2.3.3 Concept of Coevolution

Another approach to sustainability, "the coevolutionary development paradigm (Norgaard 1981, 1984a, 1984b) is designed to address, if economic development can be maintained over the long run" (Norgaard 1984b, p. 160). Development can

be viewed as a process of adaptation to a changing environment, while itself being a source of environmental change. This process is a description of coevolution. Traditional "'development'" has had a tendency to exceed the carrying capacities of ecosystems (Pearce and Turner 1990).

> Development is adopted here as a process of coevolution with the changing forest environment, while itself being a source of environmental change. Therefore, deforestation is viewed as closely linked with development. (Palo 1990, p. 155)

Coevolution in ecology was defined as interactions between two populations that are sufficiently intense and of long enough duration to influence the fitness of both (Perry 1994). Coevolution was defined by another source if both populations have a significant causal impact on each other's ability to persist (Murmann 2003).

Coevolution (e.g., Norgaard 1984b; Pearce and Turner 1990; Murmann 2003; Lamberg and Ojala 2005) is applied here as an approach to analyze evolution of sustainability both in forestry and in the society as an interactive causal process. The relevancy of ecological factors in forest transition is another main contribution of this review to our study.

2.3.4 Conclusion

Deforestation and forest transition have inter-linkages not only with socio-economic factors but also with ecological factors. They have to be included in the universal system causality model of forest transition (Fig. 2.4).

Coevolution is a dynamic concept fitting for our illustration of interactive historical development of forestry and society in Finland (Sect. 4.6).

Next we shall turn to the role of formal and informal institutions for forest transition.

2.4 Theory of Institutional Economics

2.4.1 Introduction

Our aim in this section is to review new institutional economics in order to complement the existing theoretical findings on forest transitions with informal and formal institutions.

New institutional economics (NIE) shares a kind of similar multidisciplinary approach as ecological economics. Its focus is not, however, specifically on sustainable development but, still useful for our analysis, in stressing the role of institutions in economic, political, and social change. NIE integrates economics with law, economic history, organization theory, political science, sociology, and anthropology to understand social, political, and commercial institutions. Its mission is to

explain what institutions are, what purposes they serve, how they change and how they may be reformed.

NIE is a theory-based field and therefore distinguishes itself from the old institutional economics, which tends to be more empirical. Often a distinction is made between the institutional arrangements and the institutional environment. The former refers to the specific guidelines designed by trading partners to facilitate particular exchanges. The latter is concerned with the background constraints, or "rules of the game" that guide individuals' behavior (e.g., Klein 1999).

2.4.2 Concept of Institutions

Institutions are considered here as the rules of the game. Organizations are the players, and societies, unions of societies and the whole world can be the various playgrounds or arenas of the games in economy and politics. Institutions can be formal or informal. The intimate relationship of beliefs and institutions is evident in the formal rules of a society but it is most clearly articulated in the informal institutions, such as norms, conventions, internal codes of conduct, religion, and culture (North 2005).

The informal institutions embody not only the globally common moral codes but also the norms particular to individual cultures varying across the cultures. Formal institutions can be changed by fiat, whereas informal institutions are not amenable to deliberate human manipulation due to the lack of understanding how they involve (North 2005). This may be a relevant point in trying to regulate corruption.

Institutions consist of the political structure that specifies the way we develop and aggregate political choices, and the property rights structure that defines the formal economic incentives. Institutions also consist of the social structure – norms and conventions – that define the informal incentives in the economy. Institutions allow, forbid, and set conditions for the actions of organizations and humans. Formal institutions consist of political, judicial, and economic rules and conventions. Informal institutions are made of expansions and transitions of formal institutions, moral codes and traditions (North 2005).

2.4.3 Enforcement of Institutions

The enforcement of the institutions finally decides their success in guiding human behavior. The outcome, e.g., a change in the economy, from such a game depends not only on the formal rules defining the incentive structure for the players and the strength of the informal norms but also on the effectiveness of the enforcement of the rules (North 1990, 2005).

Political parties, parliaments, governments, and city councils are examples of political organizations. Firms, trade unions, family farms, and cooperatives

exemplify economic organizations. Clubs, churches, and athletic bodies are typical social organizations, while educational bodies comprise schools, universities, and training centers.

Organizations are groups of people striving for common objectives. The institutional framework and its enforcement fundamentally influence what organizations come to existence and how they evolve. In turn organizations influence how the institutions evolve. Good institutions decrease uncertainty and costs by providing guidance of behavior in various situations (North 1990).

2.4.4 Institutional Change and Path Dependence

Institutional change shapes societal evolution and hence is the key to understanding historical change. "History matters. It matters not just because we can learn from the past, but because the present and the future are connected to the past by the continuity of society's institutions. Today's and tomorrow's choices are shaped by the past. And the past can only be made intelligible as a story of institutional evolution. Integrating institutions into economic theory and economic history is an essential step in improving that theory and history" (North 1990, p. vii).

If no transaction costs occurred in the creation of institutions history would not matter. But in the existing world transaction costs exist and no automatic adjustment towards efficient institutions will take place. Therefore, we need the *concept of path dependence* to understand this process. Path dependence narrows conceptually the choice set and links decision making through time. After a development path is set on a particular course, the network externalities, the learning process of organizations, and the historically derived subjective modeling of the issues reinforce the course (North 1990).

2.4.5 Power, Government, and Market

Politics and policies are composed of the interplay of formulating of objectives, means, and institutions with their enforcement. Who decides the objectives, means, institutions, and enforcement is a crucial issue in the politics and policies having impacts on forests and forestry.

The theory of social power and vested interests will be introduced first. Then the two sets of means to control allocation, production, and distribution of forest goods and services are illustrated: the public policy and the private/market means.

Power is a key concept in political and social sciences. Power in social sciences is defined to mean a capacity of the first actor to affect the behavior of another actor against its own will towards attaining the goal of the first actor. In this context the power of the vested interests or a group of actors sharing the same interests is most interesting. The source of power by vested interests may be based on strong finances, on familiarity of politicians and political processes, on strong ability in lobbying, on

superior information and know-how, on easy access to media, on liability to practice corruption, military power, cultural hegemony, etc.

Under dictatorships strongest vested interests, such as business, military, and religious regimes, can have dominant impacts. Along with the advancement of democracy countervailing powers, such as democratic political parties, trade unions, farmers unions, and NGOs, have their chances to balance the power arena by creating countervailing powers.

The vested interests, which have most affected the objectives and means of forest politics and policies have varied by time and country. In Europe firewood and charcoal were essential both for mining and processing of ores until about the middle of the nineteenth century. Accordingly mining companies were also able to effectively lobby their vested interests in forest policies until those days. The navy and commercial houses were among the strongest actors to safeguard their benefits during the wooden shipbuilding era.

Later on, forest industry corporations, and more recently during the twentieth century, the unions of farm forest owners grew influential, especially in Scandinavia. Most recently the nongovernmental organizations (NGOs) and the intergovernmental organizations (IGOs) have increased their power also on national forest politics.

Here we shall apply also the public choice theory, which analyzes the behavior of voters, politicians, and bureaucrats. According to this theory many regulatory agencies appear to be captured by vested interests. This may lead to corruption (Shaw 2004).

The state and the market are the two principal institutions in market economies, determining how to control forestry and the allocation of inputs, production, and distribution of forest goods and services for satisfying of human needs (Fig. 2.1).

The state and market institutions can be viewed as substitutes or complements to each other. After the collapse of the Soviet Union and a transition from a plan to a market an increased interest on the roles of the government and the market has appeared in economics in numerous other previously socialistic countries. A search for an optimum mix of markets and public policies is considered as a global priority (Stiglitz 2002), and with increasing interest during the most recent years also in forestry.

This model excludes contracts, e.g., forest certification, community institutions, such as forest management associations, environmental NGOs, traditional spiritual beliefs related to forests, or common access to recreate in all forests in some countries. They mostly represent the informal institutions as described above. Corruption can be regarded as one more informal institution. Research, development, and human capacity building, along with traditional knowledge can be identified as knowledge institutions. Knowledge and market institutions are composed often as interaction between formal and informal institutions (Fig. 2.2).

2.4.6 Conclusion

The findings of this section are summarized in Fig. 2.2. The institutions identified there will complement our previous theoretical findings in order to establish a

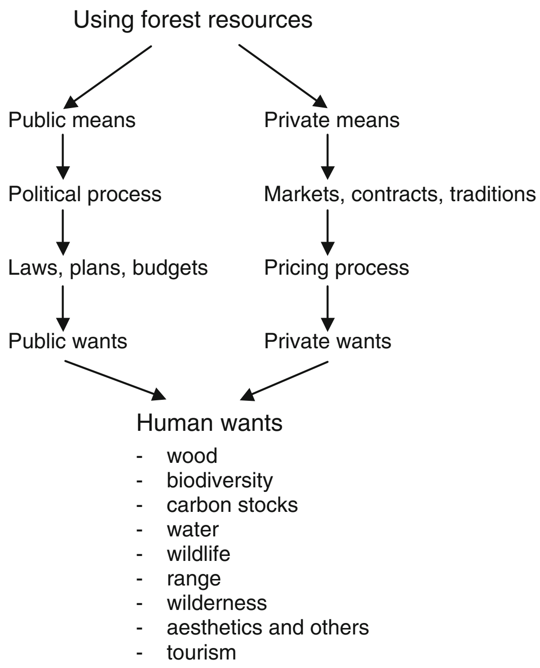

Fig. 2.1 Politics and markets as regulators of production, distribution and consumption of forest products and services (Modified from Cubbage et al. 1993)

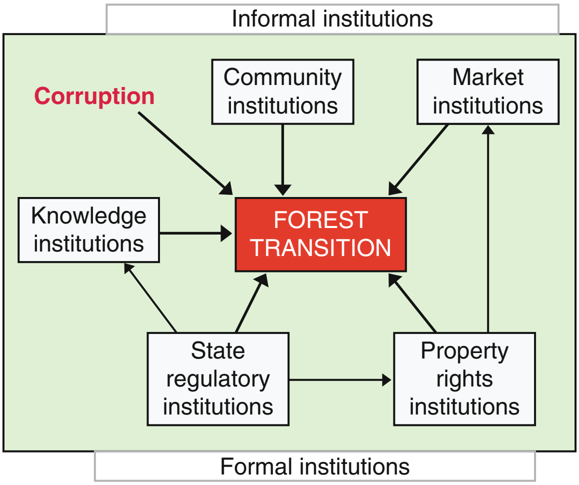

Fig. 2.2 Formal and informal institutions supporting forest transition

universal system causality model of forest transition in Fig. 2.4. The concept of institutional change and path dependence establish a theoretical core of our study.

Next we shall review the theory of property rights closer and the theory of public goods. Both play a highly fundamental role in our theory formation and understanding the complex problem of forest transition.

2.5 Theories of Property Rights and Public Goods

2.5.1 Introduction

We aim in this section to review the theories of property rights and public goods in order to understand better the process of forest transition and the roles of ownership, markets, and state regulatory institutions in this process.

Forest ownership has been analyzed in various studies (Ostrom 1999; White and Martin 2002; Humphreys 2006; Siry et al. 2009; Sunderlin et al. 2009). A surprising observation can be made. None of them based their argument on property rights theory, which has its origins in Coase (1960) and (North 1990). If transaction costs were equal to zero, no property rights theory was needed. When in the real world positive transaction costs exist, a transaction cost theory is closely linked with the property rights theory.

A property is any tangible or intangible entity, which is owned by a person or by a group of persons. We are primarily interested here in real (or land) property, which represents a tangible property. A personal property provides another example of a tangible property. Intellectual properties represent intangible properties, which include such items as copyrights, patents, licenses, etc. An official title or right of ownership establishes a relationship between the property, the owner, the non-owners, and the state.

2.5.2 Concept of Property Rights

The industrial forestry paradigm presupposes both state and market control. In order to facilitate these controls an institution of property rights (Fig. 2.2) has to be created by the state. Property rights are politically and socially accepted official rules or formal institutions, which govern the access to use forest resources. They give guidance about the rights of the owners and liabilities of the non-owners under the support of judiciary, courts, and police forces of the state.

The success in the application of property rights depends on the mutual relationships in a triangle: owners – non-owners – state. If the non-owners do not follow their liabilities, the owner has to rely on help from the state. Property rights cannot be effectively enforced without the support of society. Law and order has to prevail in society. A corrupt society cannot guarantee full enforcement of property rights (Deacon and Mueller 2006).

> Particularly, if the property right enforcement is insufficient or ineffective, forests under state, common or private property often degenerate into situations of *de facto* open access. (Bulte and Engel 2006)

There may be also a number of informal institutions, such as customs and traditions, to guide economic actors on this front. Corruption may be one widely adopted informal institution (Fig. 2.2), even if unofficial, with a strong deteriorating impact on property rights and development, and expanding deforestation.

The state of property rights has historically been a decisive factor for the successful development of nations (North 1990). In a similar way, we may assume that the state of property rights of forests and overall governance have likewise contributed toward the success or failure of sustainable forestry (Deacon and Mueller 2006; Bromley 1991, 1999).

The state has the capacity to establish socially accepted rules or judicial infrastructure by legislation for governing the rights and duties of the owners and non-owners. Four basic regimes of property rights or tenure are generally identified: open access, community property, private property, and state property (e.g., Bromley 1991; Bulte and Engel 2006).

2.5.3 Open Access and Transaction Costs

Open access is still the most common *de facto* forest property regime in the tropical countries. The absence of property rights, *de jure*, in the law, or *de facto*, in its enforcement, results in an open access regime in the forest. Typically no one's property is everyone's property. Open access to any resource results in environmental deterioration, waste, and conflict as described by Hardin (1968) in his eminent paper (Hardin mistakenly termed *open access* as *commons*).

Most forests in tropical countries are state owned, but property rights enforcement is not effective. A logical consequence is that open access conditions are largely prevailing. This process leads to continuous forest degradation, deforestation, and social conflicts.

A poor country, on the other hand, might not have adequate funding to cover the *transaction costs* needed to close the open access to forests by establishing private or community property rights or introducing other devolution of state forests. Transaction costs are composed of costs accruing in closing down open access.

Ex ante costs of closing access derive from defining property rights in the field and in the official files. *Ex post* costs of closing access are due to protecting property rights and marketing costs. Marketing costs are composed of marketing intelligence, buyer identification, marking of trees, tendering and business negations, scaling of timber, and making the exchanges (Zhang 2000).

In general, transaction costs occur in creation of institutions and in their enforcement. Transaction costs consist, in fact, of three types: costs of information, costs of bargaining, and costs of enforcement. Transaction costs are neglected in neoclassical

economics, which rely only on transformation (production) costs or assume transaction costs to equal zero. The costs of production are the sum of transformation and transaction costs (North 1990; Bromley 1991).

2.5.4 Community Property Rights

In a community property regime ownership is said to belong to a certain group of people, such as villagers or a tribe. Open access in this case is closed by the members having the right to exclude the non-members from use of a common property forest. The non-members have the duty to abide by the exclusion.

This will occur under conditions of law and order in society. Under corruptive conditions non-members may not obey their liabilities. The actors with economic and political power can overrule the rights of the common forest members. The members have often only usufructs, and sometimes also full ownership with the rights to use forest products and services and the duty of forest management (Katila 2008).

Accordingly, in theory a community property regime under otherwise fortunate conditions can lead to sustainable forestry. One distinction with the private property regime is that a community property cannot be sold, and hence the community property will not be valued and exchanged in the market. It cannot be used as collateral for credit.

A community property regime can create more equal access for its members to forest resources than an open access one. It may be consistent with many cultural and social settings. It can also internalize local externalities and local public goods and promote long-term forest management. The success of the community forest regime may be best in medium-sized groups with homogenous composition (Ostrom 1999).

Finland provides an example of a national act on community forests (www.mmm.fi), which defines the purpose as sustainable forestry and gives the organizational framework for the general meeting of members and the board with specified duties. The act also gives guidance on the establishment and closure of the common forest as well as on the points to be included in the operating rules. Each common forest, however, can have individual rules (Finland 2003). Under this act Finland has 0.4 million hectares of community forests or 2% of the total. They have been primarily established by privatizing state forests in various land reforms.

On the other hand, a community property regime may have a reduced incentive and reduced personal financial motivation for forest investments and a limited market exchange. The missing property market undermines long-term investments, because no increase in the value of the property can be realized immediately or later on.

A community property regime may also have increased costs in decision making and it may break down under adverse conditions, such as international colonial and national colonization processes, commercialization, corruption, loss of traditions, and technological change. A national act on common forests might solve some of these threats.

2.5.5 Private Property Rights

In a private property regime forest owners have the right to manage, log, and otherwise use, mortgage, rent, or sell the forest property. They also have the duty to behave according to the existing legislation, administrative orders, and societal norms. The non-forest owners have the right to only acceptable uses. The forest owners have the duty to permit the acceptable uses by the non-owners. The private property right is unique in the way that it is globally ensured by the Human Rights of the United Nations (Box 2.3).

The private property regime minimizes bureaucracy in management and has the opportunity to utilize local knowledge. The private owners are composed of families, local, national or global corporations, foundations, NGOs, etc. Accordingly, the fulfillment of the previous benefits depends partly on the kind of owner. This is also a key factor in income distribution. Family ownership is most effective to support equal income distribution, which has been identified as one factor in support of economic growth (Senghaas 1985).

The private forest property regime permits efficient market exchange of forest products and services as well as of forest properties. The latter is a highly important distinction in the community and public forest property regimes. It shortens the planning horizon of the long-term investments in forestry by facilitating capitalization of the increased value of the property either by selling the property or as collateral for credit. This gives the private forest owners incentives to intensify forest management; these incentives are mostly missing for communities and the state.

A private property regime is not expected to take into account any forestry externalities and public goods. If forestry is not the principal income earner for the private owner, he/she may have a low motivation to acquire adequate knowledge for managing sustainable forestry. Under strongly regulated property markets and weakly regulated forestry, a private forest owner may make short-term decisions, which may cause forest degradation and deforestation. If there is no regulation of property markets, forest ownership may become concentrated in the hands of corporations under a private property regime.

2.5.6 Concept of Kuznets Curve

Under clear and strong private property rights and consequent closed access to forests by the non-owners, the economic scarcity of timber is indicated by the increase of real stumpage prices (prices of standing timber). Rising real stumpage prices and the increasing value of forest will motivate the forest owners to plant more trees and also to otherwise intensify forestry management. Waste of timber in logging, transportation, and processing will be decreased due to more valuable timber (Fig. 2.3). A total forest concept covering both natural and plantation forests must be adopted in assessing of the Kuznets curve.

Box 2.3 Private Property Rights in the Universal Declaration of Human Rights by the United Nations (Cheneval 2006)

The General Assembly of the United Nations adopted and proclaimed on December 10, 1948, the Universal Declaration of Human Rights. It has 30 articles. Number 17 reads as follows:

1. *Everyone has the right to own property alone as well as in association with others.*
2. *No one shall be arbitrarily deprived of his property.*

The history of the idea of human rights is connected to the right to private (individual or common) property of indigenous peoples. In the defense of private property rights they are considered as a part of the Human Rights, of similar importance to the right to life, freedom of religion, and freedom of speech. The denial of private property rights as human rights leads to slavery and grave forms of exploitation.

The Human Rights obtained their distinct status as a means of protection of the fundamental interests of the individual person against the abuse of political power. The individual property rights were separated from the political authority and relocated in the private sphere of persons, families, and private legal persons.

The idea of human right to private property in the frontier lands of colonialism was acquired by work or first occupation. It represented a criterion in land disputes. Property rights have been gained also through land reforms, inheritance, gifts, or acquisitions under legal protection. The human rights documents guarantee basic ownership. They also protect against expropriation of property in the name of common interest without strict procedural justice and fair compensation.

Consequently, the private property right is a general right related to the moral value of human personhood. Ideally, everybody should have property. Property rights are naturally linked to housing and land rights. The private property right is a universal right to the legal empowerment of everybody.

The utility of property rights is provided in economic growth and wellbeing as well as in a general sustainable socio-political development. The judicial system thereby assures that the general benefits of the economic system of private property are accessible for the individual and not just for a particular power group.

There exists no fundamental contradiction between individual versus common property since a free system of private property enables people to own things individually or in common if they wish. A property rights system is a coherent bundle of social, judicial, and political relations. Its full enforcement is often problematic.

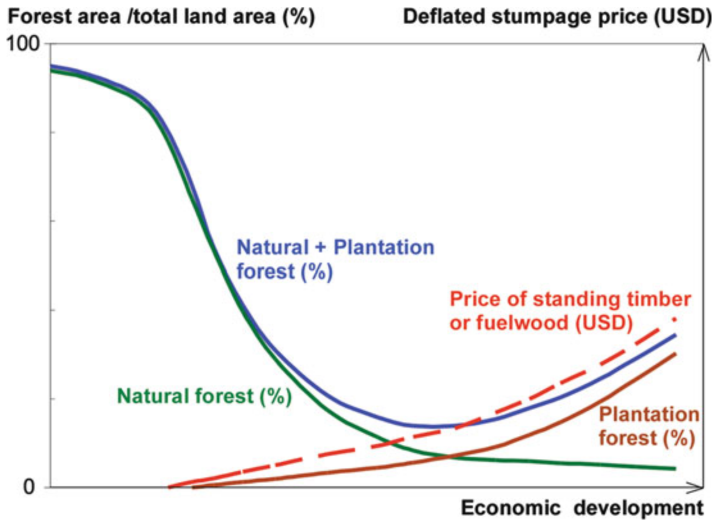

Fig. 2.3 An operational Kuznets curve: from deforestation to forest transition via increasing economic development (market institution)

This phenomenon is commonly referred to as Kuznets curve, and forest area is usually related to income per capita or economic development. Along with rising timber prices the incomes of forest owners also increase. If prices rise with increasing demand for timber, then incomes for loggers and, via linkage effects, for other citizens will increase. Forest cover has increased during recent decades in many industrialized countries, especially in Europe. Many economists and deforestation analysts rely on the appearance of this U-shaped upturn also in the tropics along with economic development (e.g., Perz and Skole 2003).

Finland provides a case of an effective Kuznets curve phenomenon (Sect. 4.1.1). The economic and social conditions are, however, different in the tropics. The stumpage markets are missing and state ownership and corruption prevail. Accordingly, only in a few cases is the model in Fig. 2.3 operational in the tropics. Douglas and Simula (2010) reviewed a number of recent studies on Kuznets curve and remain skeptical on its realization in any relevant time horizon.

2.5.7 *Public Property Rights*

A public property regime refers to exclusive ownership by the government, federal, state, or local, on behalf of the society. A forest service or a department of forestry has been vested the right to manage and use the state forests in the public interest. Citizens have a duty to observe the rules of access and use of the forests.

A state may exercise full property rights in national forests/forest reserves by managing and logging them or it may allocate logging rights (concessions) without

or with duties of certain management operations to private corporations or individuals. The markets for state forest properties are missing, bringing the similar disadvantages for long-term investments as for the community property regimes.

However, many problems have arisen with state ownership of forests: bureaucratic decision-making, lack of local knowledge, and wide-scale corruption with illegal logging and related ineffective enforcement. Especially in tropical countries the state forestry regimes have lacked the capacity to close access, and state forests have in practice become open access resources with forest degradation and deforestation (Bromley 1991, 1999; Palo 2000; White and Martin 2002; Deacon and Mueller 2006; Bulte and Engel 2006).

2.5.8 Efficient Property Rights Structure

The efficient property rights structure is universal, exclusive, transferable, and enforceable. It also requires separability of rights and a full specification of rights and duties for the property owners and non-owners.

Universality means that all resources are privately owned. Exclusivity refers to a situation where all benefits and costs accrue only to the owner. Transferability means that property rights are transferable from one owner to another on a voluntary basis.

Enforceability refers, finally, to a situation where property rights are secured by the state from involuntary seizure or encroachment by non-owners. Only the private property regime may fulfill these conditions of the efficient property rights under conditions of non-existing externalities or public goods (cf. Zhang 2000).

Comparisons of property rights regimes can find differences in their success to reduce transaction costs, to internalize externalities, and to deal with market imperfections. The regimes can also differ in their susceptibility to government failures. There also exist substantial differences in distributive and social impacts between the property rights regimes (Bulte and Engel 2006).

The forests without remarkable externalities fit best for private property rights, which can best operate with market goods. Forests with local externalities and public goods, such as local watershed, landscape or biodiversity impacts, fit best to be decentralized to local communities. Finally, forests with these properties in a national scale are best suited in the hands of the states. Global public goods can be controlled only by global conventions and their enforcements. This is a theoretical idealized description. Poor governance and corruption, however, can radically change these considerations (Deacon and Mueller 2006).

2.5.9 Forests as Public Goods

Public goods are positive externalities. Public goods differ from private goods in two fundamental ways; they are non-rival and non-excludable. One person's

consumption does not decrease the consumption possibilities of other persons without extra cost.

Non-excludability refers to a situation where no one can be prevented from consuming the good. Pure air, biological diversity, carbon sequestration, erosion control, and landscapes provide examples of public goods. Efficient and effective property rights, other legislation, and law and order may also be viewed as public goods.

Private markets cannot produce enough public goods due to the so-called problem of free riders. Therefore, private markets tend to produce too small an amount of public goods. It is difficult, sometimes impossible, to exclude people from consuming public goods. For example, everybody can breathe air or enjoy of the existence of global biological diversity (Humphreys 2006).

Public goods can appear at different scales. They can extend even worldwide. Biological diversity and carbon sequestration are examples of global public goods. Public goods can also be provided nationally, such as national defense, radio broadcasting, and the property rights of traditional knowledge in biotechnology. Also local public goods exist in the form of erosion and flood control, local public roads, and local public education.

Private individuals or corporations are not automatically motivated to produce public goods that are not transferred via markets. The governments have to launch financial incentives to support a desired quantity and quality of public goods by the private sectors or to produce public goods by themselves or to apply both instruments. However, under-provision of public goods by non-democratic governments has been generally observed (Deacon and Mueller 2006).

Public bads exist as the opposite to public goods. The extreme negative externalities are called public bads. Deforestation with serious environmental consequences provides one illustrative example. The extinction of species provides another.

2.5.10 Devolution of Property Rights

Devolution of property rights has since the 1990s become a popular activity in many tropical countries (White and Martin 2002; Katila 2008). In numerous tropical countries state forests have been devolved into community forests with varying successes. Devolution of rights has often not kept pace with devolution of duties and forests with most valuable timbers have not been decentralized (Katila 2008).

The rhetoric of devolution and participatory approaches in forest management have been increasingly adopted but government agencies have often been reluctant to give up substantial powers, resulting in half-hearted policy change with potentially counter-effective impacts. It appears clear that secure and well-defined property rights are a necessary but not a sufficient condition for any policy to reduce deforestation effectively (Bulte and Engel 2006).

2.5.11 Conclusion

No single optimum pattern of property rights exists. A wide consensus exists that states have had both government and market failures with expanding deforestation in their wide forest ownership. There may be several characteristics to be decisive in a choice of property rights, such as ecological conditions, user characteristics, timber vs. non-timber forest products as dominant products, and political economy considerations. Decentralization of state forests into private and community forest ownership may carry serious problems and risks, if devolution is enforced by a non-democratic government under corruptive conditions (Bulte and Engel 2006).

Political institutions affect property rights and property rights in turn affect deforestation. Increasing evidence indicates that abundant forests and other natural resources can lead to adoption of autocratic, non-democratic, and elitist political systems. Devolution of forests under such circumstances is doomed to failure (Deacon and Mueller 2006). It seems evident that effective corrective policies towards optimum property rights of forests will be a politically difficult and time demanding process.

So far we have learned how politically sensitive are the well-defined and secure property rights in contemporary tropical countries. They establish the foundation for successful transition from deforestation to sustainable forestry (Fig. 2.4).

Our review of the property rights exhibits one feature, how difficult the adoption of successful forest-based development can be. We shall deal next with this issue.

2.6 Forest-Based Development Theory

2.6.1 Introduction

Our aim here is to critically review and strengthen the theory of forest-based development originating from Westoby (1962) *in order to promote its role in the system causality model of forest transition* (*Fig*. 2.4).

Now we shall turn to a theory to give one partial explanation for the forest transition from deforestation of preindustrial forestry to sustainable industrial forestry. Jack Westoby published his seminal paper on "The Role of Forest Industries in the Attack on Economic Underdevelopment" in 1962. He based his work on the Hirschmanian linkage analysis (Hirschman 1958), which was specially created for development studies of resource-rich developing countries.

2.6.2 Westoby's Two Contrasting Contributions

Jack Westoby (1962) introduced some theoretical framework supported by an empirical input-output model analysis of four industrialized countries. Forest industries

had higher than average forward and backward employment and income linkages into the other sectors. Therefore, by giving priority for investments to forest industries would speed up economic growth more than investments to most other economic sectors with weaker linkage effects.

The staple theory was integrated with the neo-classical theory of export-led economic growth in this theory of forest-based development (Palo 1988). Favorable factor proportions in the form of abundance of forest resources in relation to labor and capital and limited domestic market create a comparative advantage in exporting forest resources-intensive forest products. The expanding exports of forest products will support economic growth both directly and indirectly via linkage effects and diversification impacts on the rest of the economy.

This paradigm of forest-based development can be viewed as a parallel to the industrial forestry paradigm. It formed the foundation for the forest sector development activities for FAO and other international and national development agencies until the 1970s. Finland will be introduced later (Sect. 4.5) as a successful case, where forest-based development has supported economic growth and alleviation of poverty and transition to sustainable forestry.

Westoby (1978) himself, however, became critical toward the empirical support of this theory. He had found that, even if logging of tropical timbers had expanded fast since 1962, there hardly were visible signs of forest-based development, but rather wide-scale deforestation. Westoby was followed by many other critics (e.g., Douglas 1983; Vincent 1992) and gradually new development paradigms, such as basic needs, social forestry and community forestry were created (FAO 1978, 1979; Douglas 1983).

2.6.3 Missing Reservations of the Theory

Palo (1988) analyzed this theory and its potential pitfalls. We found that the essential preconditions and reservations were missing from Westoby's (1962) presentation. Linkage refers to an investment opportunity. The realization of this opportunity depends also on the emergence of relevant entrepreneurs and other favorable factors under a fair government aiming for public good instead for some vested interests.

Westoby also failed to recognize the roles of non-corruptive conditions with closed access to forests and competitive stumpage and other markets. The expanding exports of forest products were also assumed to have an impact on income distribution. The key role of private property system in this respect was not recognized.

It has been identified earlier that Finland may provide one of the few cases, if not the only case, where the economic growth really has primarily been realized as indicated by the forest-based development theory (Kuisma 2006; Palo 2004; Wardle et al. 2003). This theory is related to Michel E. Porter's (1990) "diamond" model and cluster analysis, which in the 1990s became popular in the comparative analysis of competitiveness of economies (Hernesniemi and Viitamo 1999).

Vaara (2010) was critical of the concept of forest cluster with forest industries in the core. According to him, forest ecosystems with forest owners should establish the core. A relevant rational criterion for the choice of the core, however, is available. If we look at the input-output tables, we may realize that forestry has only a fraction of the linkages of forest industries (Palo 1988). Surprisingly, Porter (1990) never relied on input-output tables in the identification of industrial clusters.

2.6.4 Later Contributions

Malaysia was introduced by Auty (2001) as an exceptional small resource-abundant country that has managed to avoid the staple trap and to diversify its economy to competitive manufacturing under stable government and relatively low corruption. Malaysia relied in her exports in the 1960s first strongly on rubber and tin. The next decade saw increasing exports of palm oil, crude petroleum, and sawlogs. Later, sawnwood exports increased along with other manufactured goods. By 1990 the share of manufactured exports exceeded the share of primary commodities. Earlier Douglas (1983) introduced Malaysia, especially Peninsular Malaysia, as a positive case of forest-based development.

Auty (2001) edited a book entitled, "Resource Abundance and Economic Development," with 19 articles on the theme. A conclusion was drawn by the editor as follows: "Since the mid-1970s resource-poor countries have tended to grow significantly faster than the resource-abundant countries." This outcome was explained by the staples theory so that the latter group "has tended to fall into a staple trap of dependence on a weakening primary sector" while the former group has diversified their economies in a competitive way.

The book (Auty 2001) introduced also the problems for development created by soft institutions and soft governments and corruption in the contemporary developing countries. Westoby (1962) never realized such constraints. Democracy with equal income distribution, autocentric development with domestic processing, and favorable terms of trade was stressed by Senghaas (1985) for economic growth.

2.6.5 Conclusion

We will apply this forest-based development theory along with some other poverty reduction concepts and instruments (Palo 2004) in an effort to trace impacts of forest-based development on transition to sustainable forestry. This component is included in our system causality model of forest transition (Fig. 2.4).

Next we attempt to integrate the theories introduced in Sects. 2.1–2.6 in order to discover a global system causality model of deforestation and transition to sustainable forestry.

2.7 Universal System Causality Model of Forest Transition

2.7.1 Introduction

The aim of this section is to integrate the findings of Sects. 2.2–2.6 into a universal system causality model of forest transition in order to guide our observations in the historical case study of Finland and in the study of deforestation in the contemporary tropical countries.

Natural forest vegetation is superior to all other factors in erosion control. Under natural forest cover erosion remains at a minimum level due to the protection of soil by often multi-stories of tree canopies. Climate change, with less rainfall and prolonged dry periods, may seriously degrade existing forests, prevent reforestation, and support desertification (Sect. 2.3).

Accordingly, sustaining of natural forests play a key role in erosion control, especially in the tropics, where the soils are highly erosion sensitive. Erosion is relevant in tropical deforestation in the following respects. First, without erosion and human pressure a cleared forest site would become naturally reforested. Second, due to erosion most serious consequences of deforestation will take place in local, national, and international watersheds (Palo 1987).

2.7.2 Ecological Factors

Ecological factors, such as storms, earthquakes, volcanoes, lightning, and erosion, do not alone initiate any large-scale deforestation within the time horizon of a human life. Forest area seems to be higher in moist ecological zone, and lower in dry ecological zone (Palo and Lehto 2005; "Ecological factors" in Fig. 2.4).

2.7.3 Direct Local Actors

Direct local agents of deforestation are comprised of shifting cultivators, other marginal farmers, cattle rangers, fuel wood gatherers, industrial loggers, and infrastructure constructors (in the center of Fig. 2.4). They are the visible local deforestation agents, who vary a lot in their composition and intensity by continent, country, ecological, and economic zones. They have been also called as proximate causes of deforestation (Geist and Lambin 2002).

The direct local agents are deforesting because it is more profitable for them than sustainable forestry or they may lack the legal title on forest property. In the concepts of economics, the social opportunity cost of sustainable forestry is artificially made too high by underpricing the standing forests and by subsidizing conversion of forests for agriculture and agricultural production.

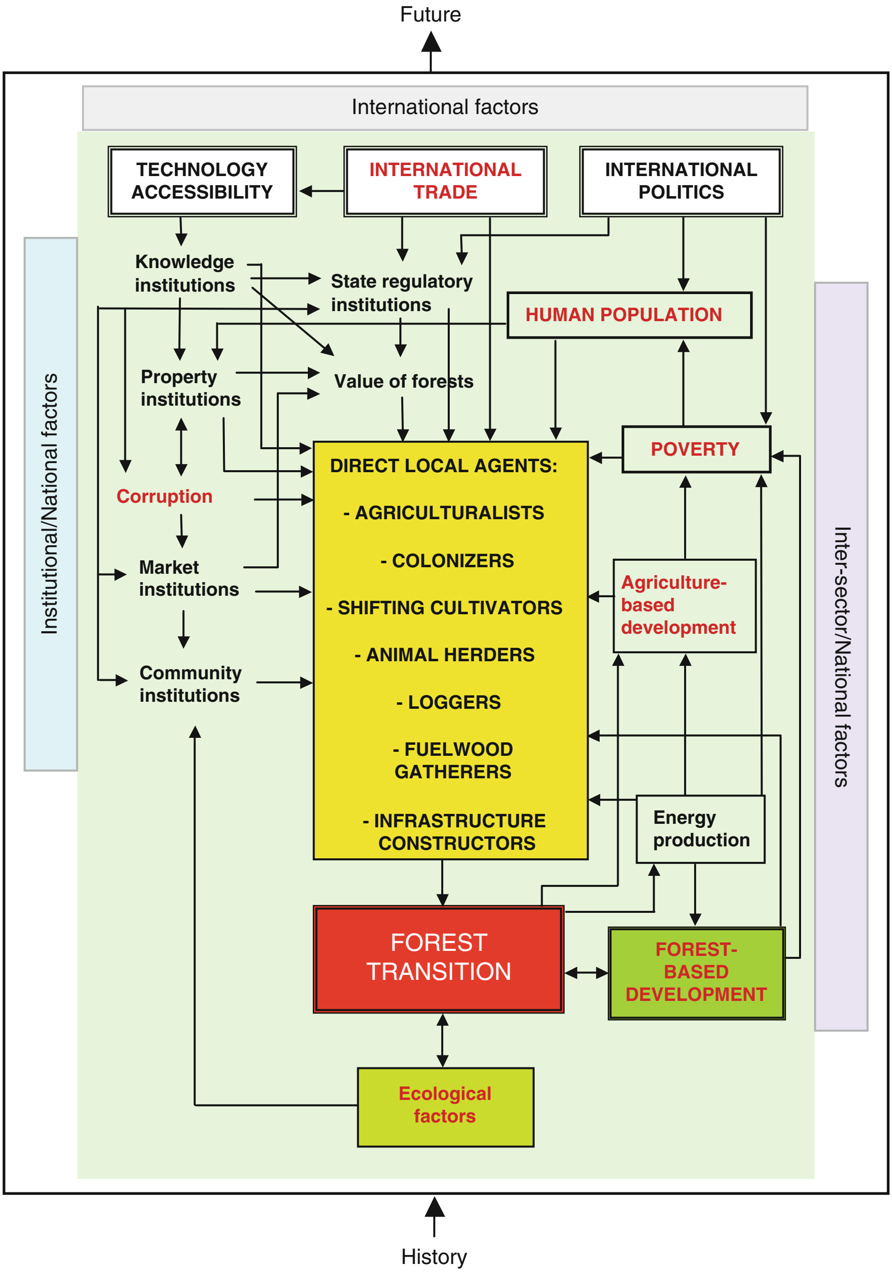

Fig. 2.4 Universal system causality model of forest transition

Local deforestation agents do not operate in a vacuum but in the context of local ecological factors and national and international institutional-socio-economic factors (Fig. 2.4). The effectiveness of direct policy control by command of the local deforestation agents will remain weak. Instead, the actions of these agents are more sensitive to the indirect market and policy instruments, such as relative prices created by various demands and financing options, prices, costs, taxes, and subsidies.

2.7.4 Formal and Informal Institutions

The relevant national and international factors supporting the changes of local actors (Fig. 2.4) are called underlying causes of deforestation. The national formal and informal institutions of Fig. 2.2 were transferred as components to the left of Fig. 2.4. The effective instruments to control deforestation will be identified among mixes of these underlying causes.

State regulatory institutions (at the top of Fig. 2.4) could play a key role in forest transition in tropical countries (government path/Sect. 2.2). The state could mobilize reduction of corruption, devolution of state forests, and create law and order in support of competitive markets for stumpage and for other forest products in order to raise the value of forests and thus reduce the social opportunity cost of sustainable forestry. The state could also reduce subsidies from agriculture for the same purpose. Under corruption and government and market failures these options may take time to become a reality. Finland provides a historical case showing how these actions have advanced forest transition (Palo 2006).

Knowledge institutions have remained at a low level in most tropical countries. Traditional knowledge on shifting cultivation or on forest management may have been declining under "modernization." Also adult literacy, especially for women and in Africa, has lagged mostly below 70% (Wikipedia 2011). These aspects deteriorate diffusion of know-how and innovations as well as slow down effectiveness of extension work.

The property rights have a fundamental role in the forest transition process (Sect. 2.5). Therefore, a whole section was devoted to this theory. The strength and enforcement of property institutions are vital aspects. Under prevailing state forest ownership corruption is a common phenomenon undermining the value of forest and the state regulation of logging (at the top of Fig. 2.4). In fact mostly *de facto* open access conditions are prevailing in the tropical state forests. Therefore it is no wonder that deforestation has been expanding.

The asymmetry of tenure has remained a major problem in the tropics. "So long as the highly skewed distribution of land, wealth and power that characterizes most tropical forested countries endures, the battle to save the tropical forest will inevitably be a losing one" (Westoby 1985). The asymmetry decreases the bargaining power of the poor and thereby the distribution of income and wealth.

Corruption is widely spread in the tropical countries (Transparency International 2010). Corruption is accompanied with state ownership of forests. Corruption is expanding deforestation indirectly by undermining both state regulation and market

institutions, which are the two principal factors to control logging and other uses of forests (Fig. 2.1). Also additional empirical evidence of the deforestation impacts of corruption among 74 tropical countries has been received (Palo and Lehto 2011).

Competitive stumpage markets could play an important role in supporting of forest transition by increasing the value of forests and alleviating of poverty. Market institutions play, however, a minor role in control of forestry activities in the tropics due to the prevailing state forest ownership with corruption, ineffective governance and unstable political circumstances.

Community institutions have since a few decades back been strengthened via the multiple activities of non-governmental organizations. Both increasing financing and know-how have been diffused to the local agents by these NGOs. Under poor governance and corruption advancement towards the forest transition has been slow. The devolution of state forests into hands of traditional communities has been increased but mostly residual forests and not full property rights have been handed down with no specific advancement towards forest transition.

2.7.5 Inter-Sector Factors

Forest-based development (Sect. 2.6) was established as one component of the system causality model (Fig. 2.4 on the right). The expanding forest industries were expected to establish higher stumpage prices and expanding incomes to forest owners and loggers. By diversifying the economy via various linkage effects alleviation of poverty and urbanization were expected. Forest-based development was also assumed to support the international trade by increasing exports or decreasing imports of forest products (at the top of Fig. 2.4). Empirical evidence to this effect was provided by the provisional case study of Finland (Palo 2006).

The role of fuelwood in energy production (on the right of Fig. 2.4) depends on its supply and prices, on forest-based development, other domestic and foreign trade supplies and prices of energy. Along with higher incomes and liberalization of trade fuelwood was expected to be substituted for fossil fuels and electricity. Empirical evidence was found in Finland since the 1950s (Sevola 1999).

Agriculture-based development was introduced by some scientists (Sect. 2.2) as a potential for slowing down deforestation (on the right of Fig. 2.4). It was expected to take place along with the intensification of agricultural production or the exodus from rural areas would leave marginal fields for natural regeneration. Empirical evidence was received among 64 tropical countries (Palo and Lehto 2005).

Natural tropical forests have been introduced as “the last resort for the poor” (Angelsen and Wunder 2003). Preindustrial forestry activities have low entry costs under open access conditions. Shifting cultivation or other related operations can be started with a few requirements in terms of skills and capital. Poverty (on the right of Fig. 2.4) is expanding deforestation (Palo and Lehto 2005), especially along with increasing population pressure (Palo 2004). Alleviation of poverty is largely based on agriculture-based developments.

The role of human population (on the right of Fig. 2.4) pressure in preventing forest transition has been under numerous debates. The impact of population depends on the context. Advanced technologies may reduce or eliminate population pressure (Palo 1994). On the other hand, population pressure at high poverty levels has been expanding deforestation (Palo 2004).

2.7.6 International Factors

International politics, technology accessibility and foreign trade are the components of the international factors at the top of Fig. 2.4.

International and global forest and environmental politics have not so far been effective in slowing down tropical deforestation and supporting forest transition. However, the "globalization path" was found recently and was caused by expanding global demand for tourism in support of forest transition (Sect. 2.2).

On the other hand, expanding exports of forest and agricultural products have increased deforestation (Vincent 1992) due to market and government failures. With more open foreign trade, more deforestation has been observed among 64 tropical countries (Palo and Lehto 2005).

The diffusion of new technology to agriculture and other industries has been too slow in the tropical countries to countervail the hindrances of forest transition, but in Finland about a century ago the diffusion of new technology for forest industries was highly essential for forest based development and forest transition (Palo 2006).

2.7.7 Nature of the System Causality Model

A fundamental feature of deforestation is that the local, national and international factors decreasing forest area are linked together as chains into a holistic causality system. The factors are also inter-sector, which means that only a few forest policy instruments may be valid and effective but the fate of deforestation is decided primarily in other quarters of societies (Bromley 1999).

The causal chains comprise predominantly positive feedback loops, which tend to accelerate deforestation (Fig. 2.4). For a long time the only effective negative feedback loop was caused by inaccessibility of forests and by successive reductions in remaining forest areas. With this kind of holistic view on the inter-sector and multilevel deforestation process we may conclude that system causality and non-equilibrium qualities are relevant for this theory (Palo 1987, 1990, 1999).

The structure of system causality has been viewed as hierarchic in terms of international, national, and local factors. In this way system causality can be interpreted as having a consistent universal structure and functioning, although a high spatial and temporal variation may prevail in the intensity of all individual causal factors (Palo 1990).

Complex systems are counter-intuitive because cause and effect are remotely located in time and space. They also tend to be insensitive to changes, even to purposeful policy changes. The few points that are more sensitive to changes are not evident; they have to be discovered through careful examination. This kind of holistic system causality applies most appropriately to the inter-sector, accelerating, socio-economic deforestation process in the tropics (Palo 1994).

The system causality model of deforestation resembles what John Stuart Mill (1848) called "chemical causation." Comparative sociologists refer to it as conjunctural or combinatorial causation, which refers to causal complexity. A causal argument cites a combination of conditions and is concerned with their interaction. It is the intersection of a set of conditions that produces many of the qualitative changes of interest, not independent or separate effects of these conditions (Ragin 1987). We have found GNP/Land area as an interaction: Population/Land area x GNP/Population. Its increase has appeared as a statistically significant variable to increase deforestation (Palo and Lehto 2005).

Why could any universal model of deforestation or forest transition be feasible, while the ecological conditions, appearance of tropical forests, socio-economic and political conditions of people, and the operations of the local actors remain highly variable? One may, however, find many similarities among the tropical countries, such as prevailing state ownership of natural forests, low stumpage prices and values of forests, wide corruption, weak and asymmetric property rights, weak governance, and low human development and economic development. Also human populations are growing fast in most tropical countries, which are also facing various asymmetry syndromes (globalization impacts, indebtedness, remnants of colonization, technology gap, etc.).

In summary, the market and the government are the two primary institutions to regulate development toward higher societal wellbeing. Under most tropical conditions they both fail to control forestry, agriculture, and land use. It is no wonder then that deforestation is continuing.

Increasing empirical evidence has been gathered on the causal role of some key underlying factors in our causality model of Fig. 2.4. Decreasing poverty and increasing agricultural productivity are expanding, increasing national income per land area, increasing openness of foreign trade, and increasing corruption are decreasing forest area in the tropics. The ecological conditions as well as the reliability of empirical data play a major role in empirical modeling of tropical deforestation (Uusivuori et al. 2002; Palo and Lehto 2005, 2011).

2.7.8 Conclusion

The system causality model of forest transition (Fig. 2.4) opens a new approach for our study. We shall apply this model, not only *ex ante* to the deforestation modeling of the tropical countries but also as an *ex post* application to Finland, which already has stopped deforestation and transited into sustainable forestry.

This model will guide our empirical observation in order to identify the relevant factors of the transition from deforestation. This approach will give extra strength to understand the underlying causes and system causality of deforestation, because we shall get novel findings from Finland's overcoming of deforestation and we can compare them along with the findings from the tropics with the forest transition theory of this book.

Next we shall turn to methods and data applied in the case studies of Finland.

2.8 Methods and Data

2.8.1 Introduction

We aim to study both qualitatively and quantitatively the coevolution of Finnish forestry and society during the historical time perspective. The phenomena of deforestation and transition to sustainable forestry are characterized with multiple conjunctural causation. We assume that our problems are also embedded historically via path dependence, politically, culturally and geographically and not only by economic, ecological, forestry and land use factors.

Variable-oriented methods, such as regression or factor analyses require reasonable number of sample countries or time-series data in a single country. We shall, for example, apply multiple regression analyses in our modeling of underlying causes of deforestation in the tropics (Chap. 5).

For Finland (Chaps. 4 and 6), we shall apply case study methods (Yin 2003) for studying the second and fourth purposes of this book (Sect. 1.4). Yin stresses the role of case-oriented methods in testing theoretical hypotheses and even in the development of new theories. Several features of the case-oriented methods make it possible to combine causal analysis, interpretive analysis, and concept formation.

2.8.2 Single Case Study Methods

First, single case study methods (Yin 2003) are applied in gathering and analyzing empirical data. In this kind of problem with only Finland as a case study object this approach is the only fitting one. Case study methods are different from surveys, where objective statistical samples are studied and the results are generalized to represent the whole relevant population. In a single case study we are looking for increasing or decreasing support for our hypotheses. Whereas in a multiple case study a single case study is replicated like a scientific experiment in order to find more or less support to our hypotheses.

Yin (2003*, pp. 13–14*) *defines*

(i) *A case study as* "*an empirical study that*

- *investigates a contemporary phenomenon within its real-life context*, *especially when*
- *the boundaries between phenomenon and context are not clearly evident*".

(ii) "*The case study enquiry*

- *copes with the technically distinctive situation in which there will be many more variables of interest than data points*, *and as one result*
- *relies on multiple sources of evidence*, *with data needing to converge in a triangulating fashion*, *and as another result*
- *benefits from the prior development of theoretical propositions to guide data collection and analysis*."

In the single case studies Yin (2003) lists five different rationales. We apply a rationale of longitudinal case study. Yin (2003, p. 42) defines this category as "studying the same single case at two or more different points in time." Its purpose, supported by our theory, is to identify "how certain conditions change over time, and the desired time intervals to be selected would reflect the presumed stages at which the changes would reveal themselves." This rationale may be described as a cross of a contemporary case study and a historical study.

The choice of a case study unit is responding to the purpose of our research project. It is critical for the success of our research. We define case study unit as the evolution and transition of forestry from preindustrial to industrial forestry and from there to postindustrial forestry. It is a kind of institutional and paradigm change of our pertinent concern and can be interpreted as a case study unit. This choice matches Yin's idea that a "case" can be some event or entity, e.g., organizational change. This aspect reflects the longitudinal case study.

The linkages between forestry and the rest of society are vital for our study. This aspect reminds an embedded case study (Yin 2003, p. 42) as a parallel to a holistic one. It is also possible to define two separate units: *observational unit* may refer to the unit in data collection and *explanatory unit* for data analysis (Ragin 1987). In this way a society would be our observational unit and forestry our explanatory unit.

In single case studies the emergence and evolution of the relevant socio-economic systems and institutions supporting sustainable forestry will be described. The historical evolutions of their transitions from open access to industrial forestry are described by applying a common conceptual framework (Chap. 2; Fig. 2.4).

2.8.3 Multiple Case Studies and Empirical Evidence

Yin (2003) identifies the purposes of applying some methods for comparative analysis of multiple case studies as drawing cross-case conclusions, modifying theories, and developing policy implications. In our book we shall compare the findings of

deforestation in the Tropics (Sects. 5.1–5.3) with our findings from the case studies of Mexico (Sect. 5.4) and Finland (Chaps. 3–4). Deforestation in the tropics (Chap. 5) will be analyzed by different methods and data explained in each section.

Empirical evidence for case studies may traditionally come from multiple sources: documents, archival records, interviews, direct observation, participant observation, and artifacts. This multiple source option is a special feature of case studies, which differentiates them from variable-oriented methods.

In the case study of Finland we are guided in gathering empirical data and information by the theoretical framework above. More specifically the global causality system model of forest transition (Fig. 2.4) is proposed to give guidance for empirical material collection.

A transition from deforestation to industrial forestry, by definition, presupposes closing down deforestation. Appearance, change, and disappearance of institutions take long maturation times. Therefore, a long time horizon is suggested for data gathering, extending over all historical and prehistorical periods for Finland. The data gathering for case studies is more complicated than for variable-oriented methods (Yin 2003).

The coevolution theory (Sect. 2.3) has inherently a multilevel approach. Therefore, it is essential in evolutionary analysis to identify the different levels of study as units of transmission. Here our primary level is the forestry sector and the secondary level is society. However, we have to also consider the various impacts, which enter Finland from the third level, the external world. Similarly, we have to identify how the forestry sector transfers its impacts at the firm level: at forest owners, forest industry firms, contractors, loggers, and other local actors.

Forests compose the fifth level in our study. Forests are changed both by ecological conditions and by the local actors (Fig. 2.4). We shall identify the various causal impacts, which are transiting the system from preindustrial forestry to industrial forestry. The sequence is often composed of impacts from the external world to the society and from there to the forestry information system, forest policy, local actors of forestry, and finally to forest ecosystems.

The sources of variation originate from the different levels. For example, wars, technology, know-how, markets, political regimes, and scientific paradigms have often arrived to Finland from the external world. Sometimes they have also appeared from the Finnish society or even from the forestry.

2.8.4 Conclusion

We have described briefly here our method and data to make a case study of Finland in transition from preindustrial forestry to industrial forestry.

2.9 Discussion

Grainger (1993) studied tropical deforestation with a system dynamics simulation model. His model was more a computation aid of a complex system than based on some integrated theory. The review of Sect. 2.2 found many later theoretical

approaches to understand forest transition but not a comprehensive theory for a complex phenomenon of tropical deforestation basically operating under non-market conditions. Therefore, the universal system causality model was developed here.

Property rights theory is perhaps the most fundamental component of our global system causality model of forest transition. Understanding the different roles and purposes of the various categories of properties: open access, community, state and private tenures, provides fundamental conditions for success. But equally important is to understand the fatal appearance of the property: forest holding – owner – non-owner – state. Without support by a state with law and order the property rights cannot be enforced.

Competitive markets cannot operate without strong and clear enforceable property rights. A forest transition from deforestation is not feasible without competitive stumpage markets. Other sectors can provide parallel cases. Therefore, the Universal Declaration of Human Rights by the United Nations in 1949 included a right to own property and a right to defend and enforce one's property rights (Cheneval 2006).

Traditionally foresters world over have carried a strong belief on the success of the state forest regime (e.g., Saari 1929; Leslie 1971) in the following aspects. A state has economies of scale and can recruit professional foresters to manage forestry. It can facilitate a long-range forest management under sustained yield forestry. A state can internalize externalities and maintain public goods. It can provide equitable access to forest by all citizens. Finally, it has been believed that a state can also facilitate adaptive management.

These arguments can be countervailed in the following three aspects. Democratic family ownership is the best form of tenure from the perspective of income distribution and the state ownership the least desirable in this respect. In theory, state ownership could benefit all citizens but according to the public choice theory and wide empirical observations there appears a strong tendency for corruption.

The experience in the tropical countries of the past half a century supports the above theory. Corruption and illegal logging on public forests are estimated to cost forest country governments at least 10–15 billion USD a year (White and Martin 2002). Corruption is undermining both the government and the market and increasing deforestation. Thirdly, state ownership misses the market of forest holdings, which shortens the planning horizon along with corruption.

There are no reliable data on the exact amount of state forest ownership in the world. White and Martin (2002) gathered global data on forest ownership and arrived to a government ownership of 77%. Siry et al. (2009) made an later estimate of 86%. Both teams were critical toward the success of government/state ownership of forests.

Due to the worldwide failure of state ownership, devolution, decentralization, and privatization of forest property rights have been ongoing in the tropics for some time but on a larger scale in China, New Zealand, and Eastern Europe (Siry et al. 2009; Katila 2008; FAO 2005; White and Martin 2002). Effective enforcement of these activities under corruption in the tropics is problematic. A poor country might not even have the adequate funding to cover the *transaction costs* needed to close the open access to forests by establishing private or community property rights in privatizing and decentralizing of state forests.

Community forests did largely appear during the pre-colonial era in the tropical countries. The colonial powers transformed them mostly under state tenure. The tropical countries continued in the same line of state ownership of forests after their independence. Bromley (1991), Ostrom (1999), White and Martin (2002), and Humphreys (2006) all favor community property as the priority forest tenure in support of sustainable forestry in the tropics. Later we will review more critical findings on the success of community forest ownership (Sect. 5.4).

Humphreys (2006), in particular, is critical of the global expansion of neoliberalism, corporate power, and privatization, which according to his view have largely supported tropical deforestation. His primary instruments for the corrective action are renewal of global governance and expansion of community ownership of forests. He is highly critical towards private forest tenure. Humphreys bases his theory to study deforestation on the theory of public goods.

Siry et al. (2009) provide evidence primarily from the United States of America but partly also from other parts of the world on benefits of private forestry. Private forests produce much more timber than their share of total global forests indicates. "Private forests also may contribute their fair share to equitable outcomes for land owners, forest users, and society as indicated by the quantitative and qualitative analyses performed here" (Siry et al. 2009, p. 9).

In this book we wish to bring an alternative positive contribution that private forestry can contribute towards forest-based development and sustainable forestry. Our view is based both on the property rights theory (Sect. 2.4) and on the impacts of the long expansion of private forest ownership in Finland (Chaps. 3–4). Furthermore, we wish in this book to analyze the role of the state forest ownership as a dominating national tenure – socialistic forestry with its linkages to corruption, open access, and deforestation (Sect. 5.1).

We believe that the theories of ecological economics, institutional economics, property rights, public goods, and forest-based development as integrated here into a universal system causality model of forest transition is innovative and productive for our empirical analysis. The basic innovation in this model is that it is applicable for studying forest transition *ex ante* and *ex post*. Accordingly, it will be applied on the historical transition of Finland from deforestation to sustainable industrial forestry and on modeling of the underlying causes of contemporary tropical deforestation.

References

Adamowicz W (2003) Economic indicators of sustainable forest management: theory versus practice. J Forest Econ 9(1):27–40

Angelsen A, Wunder S (2003) Exploring the forest-poverty link: key concepts, issues, and research implications. CIFOR, Bogor

Auty RM (ed) (2001) Resource abundance and economic development. UNU/WIDER, Oxford University Press, Oxford

Böcker CC (1829) (1929) Om skogars skötsel i Norden, I–II. C.L. Hjelt, Åbo. Summary: forestry management in Scandinavia. Silva Fennica 13/1929. Republished by the Finnish Society of Forest Science
Bromley DW (1991) Environment and economy: property rights and public policy. Blackwell, Cambridge
Bromley DW (1999) Deforestation – institutional causes and solutions. In: Palo M, Uusivuori J (eds) World forests, society and environment, vol I, World forests. Kluwer, Dordrecht, pp 95–101
Bulte E, Engel S (2006) Conservation of tropical forests: addressing market failure. In: Lopez R, Toman MA (eds) Economic development and environmental sustainability. Oxford University Press, Oxford, pp 412–452
Cheneval F (2006) Property rights as human rights. In: De Soto H, Cheneval F (eds) Realizing property rights, vol 1, Swiss human rights book. Rüffer & Rub, Zürich, pp 11–17
Coase RH (1960) The problem of social cost. J Law Econ 3:1–44
Cubbage FW, O'Laughlin J, Bullock CS III (1993) Forest resource policy. Wiley, New York
Deacon RT, Mueller B (2006) Political economy and natural resource use. In: Lopez R, Toman MA (eds) Economic development and environmental sustainability. Oxford University Press, Oxford, pp 122–153
Douglas JJ (1983) A re-appraisal of forestry development in developing countries. Nijhoff/Junk, The Hague
Douglas J, Simula M (2010) The future of world's forests: ideas vs ideologies, vol VII, World forests. Springer, Dordrecht, Heidelberg, London New York
Faber M, Manstetten R, Proops J (1996) Ecological economics: concepts and methods. Edward Elgar, Cheltenham
FAO (1949/1950) Proceedings of the III world forestry Congress, no 1–4, Helsinki
FAO (1978) Forestry for local community development. FAO Forestry Paper 7, Rome
FAO (1979) Forestry for rural communities. FAO Forestry Department, Rome
FAO (2001) Global forest resources assessment 2000: main report. FAO Forestry Paper 140, Rome
FAO (2005) State of the world's forests 2005. FAO, Rome
FAO (2007) State of the world's forests 2007. FAO, Rome
Faustmann M (1849) Berechnung des Werthes, welchen Waldboden, sowie noch nicht haubare Holzbestände für die Waldwirtschaft besitzen. Allgemeine Forst- und Jagd-Zeitung December, pp 441–455
Finland (2003) Act on jointly owned forests (109/2003). Ministry of Agriculture and Forestry, Finland
Geist H, Lambin E (2002) Proximate causes and underlying driving forces of tropical deforestation. Bioscience 52(2):143–150
Grainger A (1993) Controlling tropical deforestation. Earthscan, London
Gyldén CW (1853) Handledning för skogshushållare i Finland. H.C. Friis, Helsingfors
Hardin G (1968) The tragedy of the commons. Science 162(3859):1243–1248
Hellström E (2001) Conflict cultures – qualitative comparative analysis of environmental conflicts in forestry. Silva Fennica Monographs 2. The Finnish Society of Forest Science, Finnish Forest Research Institute
Hernesniemi H, Viitamo E (1999) Suomen energiaklusterin kilpailuetu. Summary: The competitive edge of the Finnish energy cluster. ETLA B 154. Taloustieto, Helsinki
Hirschman AO (1958) The strategy of economic development. Yale University Press, New Haven
Humphreys D (2006) Logjam: deforestation and the crisis of global governance. Earthscan, London
Hyde WF, Seve JE (1991) Malawi: a rapid economic appraisal of smallholder response to severe deforestation. In: Haynes R, Harou P, Mikowski J (eds) Preproceedings of working groups S6.03-03 and S6.10-00 of IUFRO, FAO 10th World Forestry Congress, Paris
IUCN (1980) World Conservation Strategy: living resource conservation for sustainable development. International Union for Conservation of Nature and Natural Resources
Johann E (1984) The change of conception of sustained yield within the forestry of Austria during the last two hundred years. In: Steen HK (ed) History of sustained-yield forestry: a symposium. IUFRO/Forest History Group (S6.07). Forest History Society, USA, pp 183–191

Johnston DR, Grayson AJ, Bradley RT (1967) Forest planning. Faber, London
Judeich F (1869) (1965) The Austrian cameral valuation method. Forest Chron 41(1):84–92
Judeich F (1903) Die Forsteinrichtung. In: Lorey's Handbuch der Forstwissenschaft, Band III, 2. Auflage (1. Auflage 1871). H. Laupp, Tübingen, pp 313–445
Kamarck AM (1976) The Tropics and economic development: a provocative inquiry into the poverty of nations. A World Bank publication. Johns Hopkins University Press, Baltimore
Katila P (2008) Devolution of forest-related rights: comparative analyses of six developing countries. Tropical Forestry Reports 33. University of Helsinki
Klein PG (1999) New institutional economics. In: Bouckaert B, De Geest G (eds) Encyclopedia of law and economics. Edward Elgar, Cheltenham, pp 456–489
König G (1854) Die Forst-Mathematik. Becker, Gotha
Kuhn TS (1962) The structure of scientific revolutions. University of Chicago Press, Chicago
Kuisma M (2006) Metsäteollisuuden maa: Suomi, metsät ja kansainvälinen järjestelmä 1620–1920. Suomalaisen Kirjallisuuden Seura, Helsinki
Kuusela K (1994) Forest resources in Europe, 1950–1990. EFI research report 1. Cambridge University Press, Cambridge
Lamberg J-A, Ojala J (2005) The Nordic forest industry in retrospect: an introduction. Scand Econ Hist Rev 53(1):7–18
Lambin EF, Meyfroidt P (2010) Land use transitions: socio-ecological feedback versus socio-economic change. Land Use Policy 27(2):108–118
Leslie AJ (1971) Economic problems in tropical forestry. FAO, Rome
Lihtonen V (1959) Metsätalouden suunnittelu ja järjestely. WSOY, Porvoo
Maslow A (1971) The farther reaches of human nature. Viking, New York
Mather AS (2001) Forests of consumption: postproductivism, postmaterialism, and the postindustrial forest. Environ Plann C Govern Policy 19(2):249–268
Mather AS (2004) Forest transition theory and the reforesting of Scotland. Scott Geogr J 120(1+2):83–98
Mather AS (2007) Recent Asian forest transitions in relation to forest transition theory. Int Forest Rev 9(1):491–502
Mather AS, Needle CL (1998) The forest transition: a theoretical basis. Area 30(2):117–124
Mayumi K (2001) The origins of ecological economics. Routledge, London
Mill JS (1848) Principles of political economy. Longmans, Green, London
Murmann JP (2003) Knowledge and competitive advantage: the coevolution of firms, technology, and national institutions. Cambridge University Press, Cambridge
Navarro GA (2003) Re-examining the theories supporting the so-called Faustmann formula. In: Helles F, Strange N, Wichmann L (eds) Recent accomplishments in applied forest economics research, vol 74, Forest sciences. Kluwer, Dordrecht, pp 19–38
Norgaard R (1981) Sociosystem and ecosystem coevolution in the Amazon. J Environ Econ Manage 8(3):238–254
Norgaard R (1984a) Coevolutionary agricultural development. Econ Dev Cult Change 32(3):525–546
Norgaard R (1984b) Coevolutionary development potential. Land Econ 60(2):160–173
North DC (1990) Institutions, institutional change and economic performance. Cambridge University Press, Cambridge
North DC (2005) Understanding the process of economic change. Princeton University Press, Princeton
Ostrom E (1999) Self-governance and forest resources. CIFOR Occasional Paper 20, Bogor, Indonesia
Palo M (1987) Deforestation perspectives for the tropics: a provisional theory with pilot applications. In: Kallio M, Dykstra D, Binkley C (eds) The global forest sector: an analytical perspective. IIASA and Wiley, London, pp 57–89
Palo M (1988) The forest-based development theory revisited with a case study of Finland and prospects for developing countries. In: Palo M, Salmi J (eds) Deforestation or development in the third world? vol II. Research Papers 309. Finnish Forest Research Institute, Helsinki, pp 13–157

Palo M (1990) Deforestation and development in the third world: roles of system causality and population. In: Palo M, Mery G (eds) Deforestation or development in the third world? vol III. Research Papers 349. Finnish Forest Research Institute, Helsinki, pp 155–172

Palo M (1994) Population and deforestation. In: Brown K, Pearce DW (eds) The causes of tropical deforestation. UCL Press, London, pp 42–56

Palo M (1999) No end to deforestation? In: Palo M, Uusivuori J (eds) World forests, society and environment, vol I, World forests. Kluwer, Dordrecht, pp 65–77

Palo M (2000) Global prospects on deforestation and forest transition. In: Palo M, Vanhanen H (eds) World forests from deforestation to transition? vol II, World forests. Kluwer, Dordrecht, pp 3–21

Palo M (2004) Poverty reduction by tropical forests: rhetoric or a viable option? In: Sim HC, Appanah S, Youn YC (eds) Forests for poverty reduction: opportunities with clean development mechanism, environmental services and biodiversity. FAO, Bangkok, pp 7–24

Palo M (2006) Coevolution of forestry and society in Finland: from preindustrial to industrial forestry. In: Rauhalahti M (ed) Essays on the history of Finnish forestry. Vuosilusto 2004–2005. Finnish Forest History Society/Lusto, Punkaharju, pp 49–99

Palo M, Lehto E (2005) Poverty reduction by tropical forests? In: Tyynelä T, Pelkonen P (eds) In search of a total value for forests. Silva Carelica 50. University of Joensuu, pp 44–61

Palo M, Lehto E (2011) Poverty and deforestation in the tropical countries: roles of corruption and other underlying factors. A manuscript available from the authors

Palo M, Mery G (eds) (1996) Sustainable forestry challenges for developing countries, vol 10, Environmental science and technology library. Kluwer, Dordrecht

Parry BT, Vaux HJ, Dennis N (1983) Changing conceptions of sustained-yield policy on the national forests. J Forestry 81(3):150–154

Pearce DW, Turner RK (1990) Economics of natural resources and the environment. Harvester Wheatsheaf, London

Perry DA (1994) Forest ecosystems. Johns Hopkins University Press, Baltimore

Perz SG (2007) Grand theory and context-specificity in the study of forest dynamics: forest transition theory and other directions. Prof Geogr 59(1):105–114

Perz SG, Skole DL (2003) Secondary forest expansion in the Brazilian Amazon and the refinement of forest transition theory. Soc Nat Resour 16(4):277–294

Porter ME (1990) The competitive advantage of nations. Free Press, New York

Ragin CC (1987) The comparative method: moving beyond qualitative and quantitative strategies. University of California Press, Berkeley

Rudel TK (1998) Is there a forest transition? Deforestation, reforestation and development. Rural Sociol 63(4):533–552

Rudel TK, Coomes OT, Moran E, Achard F, Angelsen A, Xu J, Lambin E (2005) Forest transitions: towards a global understanding of land use change. Global Environ Change 15:23–31

Saari E (1929) Eri metsänomistajaryhmät metsätalouden harjoittajina. Suuri Metsäkäsikirja, Helsinki

Saari E (1949) The sustained yield in forestry. In: Proceedings of the III World Forestry Congress, no 1: General papers and their summaries, Helsinki

Saastamoinen O (1996) Change and continuity in the Philippine forest policy. In: Palo M, Mery G (eds) Sustainable forestry challenges for developing countries, vol 10, Environmental Science and Technology Library. Kluwer, Dordrecht, pp 121–139

Sachs JD (2005) The end of poverty: economic possibilities for our time. Penguin, New York

Samuelson PA (1976) Economics of forestry in an evolving society. Econ Inq 14(4):466–491

Schuler A (1984) Sustained yield forestry and forest functions, as seen by Swiss foresters in the nineteenth century. In: Steen HK (ed) History of sustained-yield forestry: a symposium. IUFRO/Forest History Group (S6.07). Forest History Society, USA, pp 192–201

Senghaas D (1985) The European experience: a historical critique of development theory. Berg, Leamington Spa

Sevola Y (1999) Puun käyttö. In: Andreasson K, Helin V (eds) Suomen vuosisata: Trendit. Tilastokeskus, Helsinki, pp 117–121

Shaw JS (2004) Public choice theory. Article in the Concise encyclopedia of economics. http://www.econlib.org/library/Enc1/PublicChoiceTheory.html. Cited Feb 2011

Siiriäinen A (1987) Swidden cultivation in the precolonial history of Africa. In: Raumolin J (ed) Special issue on swidden cultivation. Suomen Antropologi 12(4):269–278

Siry JP, Cubbage FW, Newman DH (2009) Global forest ownership: implications for forest production, management, and protection. XIII World Forestry Congress, Buenos Aires

Steen HK (ed) (1984) History of sustained-yield forestry: a symposium. IUFRO/Forest History Group (S6.07). Forest History Society, USA

Stiglitz JE (2002) Globalization and its discontents. W.W. Norton, New York

Sundberg U, Silversides CR (eds) (1988) Operational efficiency in forestry, vol 1: Analysis. Kluwer, Dordrecht

Sunderlin WD, Larson AM, Cronkleton P (2009) Forest tenure rights and REDD+: from inertia to policy solutions. In: Angelsen A (ed) Realising REDD+: national strategy and policy options. CIFOR, Bogor, pp 139–149

Transparency International (2010) Corruption Perceptions Index (CPI). http://www.transparency.org/policy_research/surveys_indices/cpi. Cited Feb 2011

Uusivuori J, Lehto E, Palo M (2002) Population, income and ecological conditions as determinants of forest area variation in the tropics. Global Environ Change 12(4):313–323

Vaara L (2010) Tehottomuutta, terroria ja tiedotusta maan metsissä. Taloustieto, Helsinki

Vehkamäki S (ed) (2006) Metsät ja hyvä elämä: Monitieteinen tutkimusraportti. Metsäkustannus, Helsinki

Viitala E-J (2003) Normaalimetsän optimaalisuudesta. Research Papers 895. Finnish Forest Research Institute

Vincent JR (1992) The tropical timber trade and sustainable development. Science 296(5064):1651–1655

Wardle P, Jansky L, Mery G, Palo M, Uusivuori J, Vanhanen H (eds) (2003) World forests, society and environment – executive summary. The United Nations University, Tokyo

WCED (1987) Our common future: report of the World Commission on Environment and Development. Oxford University Press, Oxford

Webster (1989) Webster's ninth new collegiate dictionary. Merriam-Webster, Springfield

Westoby JC (1962) Forest industries in the attack on economic underdevelopment. Unasylva 16(4):168–201, FAO, Rome

Westoby JC (1978) Forest industries for socio-economic development, Eighth World Forestry Congress. FID/GS, Jakarta

Westoby JC (1985) Forest policy: one step forward. Unasylva 37(148):55–57

White A, Martin A (2002) Who owns the world's forests? Forest tenure and public forests in transition. Forest Trends and Center for International Environmental Law, Washington

Wikipedia (2011) Literacy. Article in Wikipedia. http://en.wikipedia.org/wiki/Literacy. Cited Feb 2011

Wunder S (2000) The economics of deforestation: the example of Ecuador. Macmillan, London

Xu J, Yang Y, Fox J, Yang X (2007) Forest transition, its causes and environmental consequences: empirical evidence from Yunnan of Southwest China. Trop Ecol 48(2):137–150

Yin RK (2003) Case study research: design and methods, vol 5, 3rd edn, Applied social research methods series. Sage, Thousand Oaks

Zhang Y (2000) Deforestation and forest transition: theory and evidence in China. In: Palo M, Vanhanen H (eds) World forests from deforestation to transition? vol II, World forests. Kluwer, Dordrecht, pp 41–66